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EFFECTS OF VOLUNTARY CONTROL ON PERFORMANCE RESPONSE UNDER STRESS

by

CHRISTINA SHAWN MORRIS
B.S. University of Central Florida, 1998

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Department of Psychology in the College of Arts and Sciences at the University of Central Florida Orlando, Florida

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ABSTRACT

Recent stressful environments within military and non-military domains are producing a new challenge for the lab-based study of stress on task performance, one that requires knowledge of underlying cognitive-motivational and goal orientation factors. Results of recent stress on task performance research traditionally employ metaphorical explanations (i.e., resource theory) in order to rapidly apply stimulus-response outcomes to the real world counterparts. This dissertation provides an alternative perspective about these metaphorical, or black box, interpretations and reveals how they may be confounded with respect to the intended real world counterpart. To examine how voluntary human control can influence traditional stress/no-stress research findings, traditional as well as exploratory paradigms were presented. Both noise and time pressure conditions produced significant differences between experimental and control groups on visual discrimination. However, when analogous cash payment-contingency conditions were employed, the traditional stress/no-stress findings were not evident. In addition, a second experiment revealed that this trend of differences (and non-differences) held consistently over 30 minutes of interrupted task performance time.

This study indicates the importance of developing more diagnostic measures that include assessments of how the differences between participants’ and the generalized operators’ goals and motivations may alter results in stressful task environments.
ACKNOWLEDGEMENTS

The author acknowledges the support of the Department of Defense Multidisciplinary University Research Initiative (MURI) program administered by the Army Research Office under Grant DAAD19-01-1-0621. P.A. Hancock, Principal Investigator. The views expressed in this work are those of the author and do not necessarily reflect official Army policy.
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<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>OPC</td>
<td>Overall Percent Correct</td>
</tr>
<tr>
<td>PC</td>
<td>Percent Correct</td>
</tr>
<tr>
<td>MS</td>
<td>Mean Speed, or number of items attempted</td>
</tr>
<tr>
<td>MC</td>
<td>Mean Correct, or number of items responded to correctly</td>
</tr>
<tr>
<td>ANOVA</td>
<td>Analysis of Variance</td>
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<tr>
<td>MANOVA</td>
<td>Multivariate Analysis of Variance</td>
</tr>
<tr>
<td>SPL</td>
<td>Sound Pressure Level</td>
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<tr>
<td>Db</td>
<td>Decibels</td>
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<tr>
<td>SDL</td>
<td>Scenario Description Language</td>
</tr>
<tr>
<td>PCL</td>
<td>Program Control Language</td>
</tr>
<tr>
<td>DSSQ</td>
<td>Dundee Stress State Questionnaire</td>
</tr>
<tr>
<td>CITS</td>
<td>Coping Inventory for Stress</td>
</tr>
<tr>
<td>BPS</td>
<td>Boredom Proneness Scale</td>
</tr>
<tr>
<td>AMI</td>
<td>Achievement Motivation Index</td>
</tr>
<tr>
<td>CS</td>
<td>Competitiveness Scale</td>
</tr>
<tr>
<td>M</td>
<td>Mean</td>
</tr>
<tr>
<td>SD</td>
<td>Standard Deviation</td>
</tr>
<tr>
<td>SE</td>
<td>Standard Error</td>
</tr>
<tr>
<td>t</td>
<td>T-statistic</td>
</tr>
<tr>
<td>F</td>
<td>F-statistic</td>
</tr>
<tr>
<td>$\eta^2$</td>
<td>Eta squared</td>
</tr>
<tr>
<td>IVOC</td>
<td>Index of Voluntary Control</td>
</tr>
<tr>
<td>TI</td>
<td>Task Interest</td>
</tr>
<tr>
<td>DE</td>
<td>Directed energy</td>
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CHAPTER ONE: INTRODUCTION

Measurement in human factors is the antithesis of weather in daily life. As has been often noted, everyone talks about the weather, but nobody does anything about it. In Human factors everyone engages in measurement, but few discuss it. (Kantowitz, 1992)

The study of human performance in stressful and complex environments is a branch of science that is now, more than ever, essential for designing and optimizing operations for military as well as civilian operations. As novel and ever evolving technologies flood the marketplace and the military world, human operators are required to adopt and maintain previously endorsed performance standards. These dynamic and now more technologically complex operational environments present an entirely new and different challenge for the study of stress on task performance. Traditional research paradigms for human-machine performance models as well as the production of behaviorally sound simulated agents need to be addressed in light of these substantial changes.

Previous human performance studies have resulted in models, formulae, and equations that seek to predict cognitive and physical performance within stressful or aversive environments. However, there is a need for validation strategies in order for diagnostic and predictive models to be improved. This is especially true when the applied research questions involve armed conflict, advanced weaponry, and/or when the implications of degraded performance can result in injury or fatality. The contemporary research trend favors rapid technological prototyping, marketability, and further product development leaving little opportunity for revisiting scientific standards and development of valid, reliable, and accurate human performance tools. In addition, relatively little government funding is directed toward understanding the cognitive “how, why, and where” factors involved in human mental
performance. This is also often the case for human factors research, which is almost always
directed at the “what”, or the composition of performance outcome. With the lack of validation
efforts along with the push toward advanced technologies and rapid prototypes, research validity
is becoming reliant on the intrinsic interests of academics. It is under circumstances such as these
that Kantowitz describes a lack of regard for thoughtful measurement and ultimately
external/ecological validity is compromised.

The human experience of stress and the outcome of their task performance often are
tightly linked. We know this because the metrics for objective task performance are not very
difficult to develop. As such, there is little question surrounding the “what” of performance that
becomes affected by stress. For example, human output such as percent of correct responses,
reaction time, number of errors, and other observable variables are often found to covary with
levels of observable stress. Alternatively, the underlying perceptual and cognitive factors, along
with their interactions that precipitate those outcomes remain unclear, or metaphorically inferred
due to the complexity of its measurement.

As a result of weak measurement and the demand for the rapid implementation of applied
research results, metaphors are often used in place of actual explanation. An example of this is
evidenced in a traditional popular metaphor within human performance and stress research. It is
the most readily available, and thus most often applied (and misapplied) explanation for stress
effects on human performance. The explanation given is that human cognitive, mental, physical,
or attentional resources become depleted under increases of complexity, stress, duration/time,
and other workload factors. Unfortunately, this explanation leaves resources undefined.

The notion that resources diminish under stress provides no explanation as what
resources actually are. We are not informed as to how or why they deplete, where they come
from, or where they go. The problem however is not solely with the metaphorical nature of resource theories. All domains of science apply metaphors successfully to some extent and basic research can often capitalize on the simplicity and utility that metaphors provide. Rather, the problem exists when immediate application is desired from those research findings. Metaphorical explanations rarely provide realistic and employable solutions that persist over time and across various contexts. Problems also arise when i) participants typically used in applied research (i.e., university students) have goals, personalities, motivations, and abilities which differ from their generalized real world counterpart (e.g., soldiers, firefighters, security guards). Ecological validity is immediately compromised due to the research lacking what Kantowitz refers to as subject representativeness, ii) The tasks that are often employed in stress research are often either boring and/or irrelevant to the participant’s interests in succeeding. This presents a new experimental confound, that until this point, was only alluded to by Kantowitz, (1992) as a “subject by setting interaction”. The loosely defined metaphorical explanation that is commonly used and referred to as “diminishing resources under stress”, suggested here, to be partially accounted for by participants’ goals and motivations to succeed in the task while undergoing stressful or aversive conditions (e.g., boredom, noise, heat). Stressors can simply impose a distraction, or decrease motivation to succeed in a task, a task where usually real world counterparts are highly motivated to succeed despite a stressor (e.g., life or death, job relies on performance, rewards offered). It remains unknown therefore, whether the degree of “voluntary control” is responsible for such diminished human resources or, if diminished ability to perform the task is due directly to stress.

The purpose of this work is to define the differences among participants’ voluntary control, especially in aversive experiments. The experiments are designed to determine if
participant voluntary control is a factor in commonly observed stress and task performance experiments. This study will evaluate what these various levels of participant performance are due to different goals versus their inability to perform successfully (or resource depletion). To accomplish this, the procedures will manipulate motivation levels within commonly studied aversive conditions in the effort to reveal participant task avoidance and varied voluntary control. With participants being University students performance under stress is expected to be significantly lower compared to analogous control conditions. However, student performance is expected to be indifferent, or at least higher within analogous stress conditions with manipulated increased goals and motivation. This study will thereby suggest that the metaphorical “resource theory” itself may be inadequate to explain performance differences, or an alternative but non-exclusive explanation would be that the concept of resources are in some way replenished by increasing motivations and goals.
CHAPTER TWO: REVIEW OF LITERATURE

Progress in Task-Performance Research

In order to understand the dynamic nature of human performance within aversive environments, observational tools and methods must address the more covert human variables. One prominent school of psychology, the behaviorists, began with the notion that it was unnecessary to explore covert or internal human responses to stress since the ability to distinguish internal subjective states was highly debatable. With the recent advents of cognitive metaphors such as resource theory and computational approaches, the historical view is revisited within one emergent sub-discipline of psychology, namely human factors and the human performance sciences.

Since the early 1600’s, when Descartes generated his perspective on the mind-body problem, the bases for mechanistic approaches to cognition were set forth. His notion was that humans had no direct access to reality, but instead interpreted the world depending on immaterial mental objects that the mind manipulated. This mechanistic approach persisted for centuries. By the 19th century, structuralists such as Wundt and Tichener advocated the study of the human’s inner or covert experiences. Unfortunately the tools and methods for understanding covert responses to stress did not exist and were based solely on introspection. It is no surprise that the next movement of experimental psychologists, the functionalists, were more interested then in the action of an organism. In agreement the behaviorists went on to regard the investigation of covert mental behavior as unnecessary and unscientific. Thus, years of psychological studies were exclusively focused on observable events. And the interpretations of stimulus and response characteristics went on ambiguously or completely undefined. By the early 20th century human
performance in the industrial workforce was of high interest. Fredrick Taylor’s study of time and motion as well as concurrent performance and psychological testing of shell shock during WWI made the role of covert emotional factors simply labeled as stress to be crucial (Selye, 1983). The study of stress, human performance, and operator error became a necessary science leaving the behaviorist view of experimentation with little to contribute. By the 1950’s the cognitive revolution, as reported by Dember, was formed regarding behaviorist methods as an inaccurate approach in explaining complex human performance (Gardner, 1987). As technological advances defined the human performance movement of the 20th century, psychological science again revisited human performance from a stimulus-response approach. The metaphor of mind has always been associated with the highest level of contemporary technology (phone and bandwidth etc) and as such, the metaphor of human cognition being analogous to the processes of a computer, emerged in theoretical information processing models (Eysenck, & Keane, 1995). This explanation of human performance however, only slightly extended the behaviorists black box approach by describing cognition as a number of stages through which information must pass.

Many new and fascinating discoveries came out of the computational cognitive psychology approach around the 1950’s and as such it has certainly earned its place. One example is Miller’s (1956) analysis of human limitations in short-term memory with respect to the amounts of information that could be retained. His work aided in the next developments of cognitive channels, capacity limitations, theories of attention and cognitive filtering, and eventually when ambiguous results persisted within those concepts, the notion of information rate limiting gates (Broadbent, 1958) emerged. While the contributions of modeling cognitive processes are crucial for our current state of progress, revisited is the previous problem of
lacking covert and mentalistic observation. Cognitive processing and states continue to be statically defined without considering the covert concepts such as “meaning” interpreted by the human and the conscious experience of having mental states (or qualia). These issues are still far removed from and overlooked in most human performance sciences. Clearly, however, it is apparent that the human mind is not completely analogous to the computer. As Solso (1991) indicated:

Unfortunately what computers do well; perform high-speed mathematical functions, abide by rule-governed logic, humans do poorly. And what humans do well; form generalizations, make inferences, understand complex patterns, have emotions, computers do stupidly or not at all.

**Computational, Mechanistic, and Resource Theories**

The cognitive and mechanistic approaches described thus far have contributed to explaining human processing stages and static functions of the operator under stress however they do not account for any energetic and control aspects occurring in the human during performance. On the other hand, during the 1970’s, theories of attentional resources began to explore the limitations of human performance as functions of other variables such as task demands and available cognitive capacity.

Explanation of human performance in terms of limited cognitive capacity began with Kahneman (1973) who described cognitive capacity as a function of resource capacity modified by arousal. While Kahneman recognized the importance of covert mentalistic processes such as arousal, others (e.g., Norman & Bobrow, 1975) likened cognitive resources to a battery, requiring energization but limited to some fixed amount. With fixed resource theories, human performance is suggested to be the direct result of a limited resource supply that diminishes over
time. This explanation of a single pool of resources has been able to adequately explain the tradeoffs between tasks found in human performance during dual-task experiments. The fixed resource explanation has also been supported by correlated measures of self-reported workload during tasks (Warm & Dember, 1998). This approach has certainly contributed to a useful abstract representation of the energetic aspects of performance, however it leaves no room for human control.

Another similar view that describes resources as “multiple”, coming from multiple human cognitive capacities, has also gained popularity. The multiple resource theory illuminates the properties of tasks as drawing on different operator resources (Navon & Gopher, 1979). The concept of multiple resources has been able to adequately explain experimental results of similarity effects across tasks. When characteristics of a task use similar processing resources (e.g., two visual task components) more cognitive interference will occur from limitations to the shared resource than dissimilar processing (e.g., visual and auditory) drawing from separate resource pools (Wickens, 1980). Arguments exist however that the actual source of interference in multiple resource theory is primarily a physical interference. For example, the interferences found when two visual task components are used in an experiment is often due to the physical inability to shift fixations (Wickens, 1991).

Both single and multiple resource theories are lacking in providing any useful definition of a resource. While it has been common for cognitive models to use hypothetical structures to explain phenomena, there is often a strong link between brain function and the model components. Navon (1984) describes resources as a “soup stone”, a component of theory added for essentially superstitious reasons, rather than because it has any real explanatory value. Allport (1980) makes another strong argument that the premise of resources, with its assumption
of serial processing, contradicts many findings that the brain functions in parallelism.

**Operators Goals, Motivations, and Experimental Validity**

Human cognitive resources have been explored and defined in great detail by use of vigilance type tasks in experiments. These tasks are often used in stress and performance research in order to determine participant’s ability to perform tasks requiring mental abilities such as sustained attention. The ability to sustain attention over time is considered a direct function of available cognitive resources as in the resource theories described above. Benefits to using vigilance tasks are evidenced in their simplicity and versatility of physical task features and thus they can represent a variety of analogous sustained attention tasks as found in the real world. For example, the tasks can represent the physical characteristics of a radar system or a security-screening device with the exact shapes and response functions found in the real-world radar monitoring and security screening tasks.

With resource models, personal computers and advanced experimentation, vigilance tasks now appear to offer high external validity and generalizable results - for one parameter of the environment only. The argument herein is that while the physical characteristics (e.g., object shapes, input devices) of the task and operations are replicated in the vigilance experiment, the surrounding context composed of individual and situational characteristics are not. Kantowitz described three main components in an experiment that need to be considered and lead to validity. 1) Subject representativeness or the extent to which the subjects/participants represent the real-world individuals the research is to be applied to. 2) Variable representativeness which depends on the practical experience of the researchers to select representative variables and
proper use of theory to help select representative variables, and 3) Setting representativeness which is closely aligned with ecological validity and operational fidelity referring to the coherence between the experimental situation and the target situation to which the research must be applied. Kantowitz goes on to describe that the importance of setting representativeness is vastly overrated and that great physical fidelity may increase realism of the setting but that actual generalizability and thus validity emerges from the comparability of psychological processes in test and target environments, not from improvements in realistic physical task characteristics. Wickens, (2000) elaborated on this form of experimentation and suggested that meeting internal validity and reliability does not provide an applicable and consistent experimental outcome for real-world high stress settings. It is essential that research involving stress and operator performance meet a high level of generalizability, or external validity as well. The primary purpose human factors and performance research is to apply the findings for rapid generalization and developments and therefore, it is not only desired, but required that stress and performance experiments maintain a high degree of external validity. While in experimental settings there is always a tradeoff between internal and external validity, one must keep in mind that it is from these types of research projects that findings are immediately interpreted and applied in the real world. If external validity is weak, human error and fatality is almost certain

In order use vigilance tasks to infer an operator’s resource capacity, additional environmental or task related stressors (e.g., heat, noise, complexity) are added to the vigilance task. In these stress conditions operators display physical and cognitive attentional narrowing on the tasks, resulting in significantly more errors (Hockey, 1970). Since vigilance type tasks are relatively boring, the decline in an operator’s performance is often referred to as a function of the underload region of stress that is imposed on the individual (Hancock & Warm, 1989). When we
refer to the real-world radar operator who is assigned to the real world version of the vigilance task, there are usually lives at stake. The operator’s performance on the task is essential for the safety of himself and others, thereby placing a great degree of responsibility and motivation to succeed on them. Likewise the security screener is responsible for detecting explosives, weapons, and other hazardous materials that could destroy many lives if gone unnoticed.

**Applied Experimental Research Denotes Ecological Validity**

A major insight in behavioral research in the last decade of the 20th century was the importance of context in predicting human behavior response. It has become progressively clear that results from the sterile laboratory have only a restricted chance to predict performance in the real world. The complicated tapestry of environmental influences are not merely “unwanted” variance to be isolated and excused, they are crucial interactive facets of the performance portraiture. (Hancock, 2003)

The importance of an ecological perspective was first discussed by Brunswick (1956) and subsequently by Gibson (1966, 1979) and denotes psychology as the study of the interaction of the human organism and its environment. At this point in time there was a general neglect of the dynamics of the interaction. Some still argue that the dynamic and unstable environment, as well as the dynamic and unstable organism, should produce more of an explanation than the interaction of the human organism and its environment. This is a perspective more in line with the computational and mechanistic approaches mentioned previously. This perspective represents man and environment as two tactile but unchanging (or with simple minor computations) entities merely interacting, in an additive sense. One of the most often encountered debates in academic psychology is that people are often studied under isolated and unrealistic conditions in a controlled experiment (Chignell, Hancock, & Takeshita, 1999).
The primary objective in human factors and human performance research is to be able to
generalize results found in the lab to actual real-world settings. Rapid developments in
technology are often the direct result of lab based research and consequently the results of these
experiments are interpreted more rapidly than they should be. While most human performance
research is focused and conducted in an applied setting opposed to a basic study setting, the
concept of “generalizability” is often neglected in hopes to modify existing theories. When
theory modification drives the professionalism of the researcher, application and generalizability
is compromised. Stress and performance research is one of the few areas where both application
and theoretical issues are crucial and must be the product. The human operator and work
environment are suggested to be reciprocally coupled and cannot be studied independently of
one another (Vicente, 1995) as is often the case when theoretical contributions are the goal.
However, the study must have a functional description of the domain in which behavior is taking
place as well as the cognitive components to be affected. This concept is often neglected in the
research settings where rapid application is the main goal. As Vicente indicated, the elements of
the human and environment cannot be separated. They produce interactions that can only be
studied when these interactions are considered. For example, the environmental elements act as a
dynamic set of constraints that define and produce human actions that are in turn modifying the
environmental constraints and perception thereof.

The basic experiments and simple tasks that are most used in general psychology are
typically too minute and different from the ecology of operational environment and cannot
provide suitable guidance for application. The tasks encountered in the real world invoke
qualitatively more than the additive consequences of differentially and separately evaluated
cognitive components. Meta-analyses are often used in attempt to organize and derive models
from many different experimental results, again in an additive attempt to interpret an ecologically complicated man-environment system. Problems arise in that so many different measures and constructs are used, thus making it impossible to compare human, task, and environment processes across studies. This mechanistic and computational approach to human performance creates problems when attempting to describe elements of covert and abstract human processes such as motivation to succeed. The directedness and purposiveness of human behavior is affected by many components often neglected in human performance research.

**Voluntary Control Theory**

Theory is the best practical tool. Once available can be used cheaply and efficiently to aid in measurement and system design. (Kantowitz, 1992)

The computational metaphors, resource theories, information model, and other mechanistic explanations have been the dominant approaches toward explaining human performance in aversive environments. All of these paradigms however, imply human passivity and do not account for psychological moderators of performance (e.g., goals, percepts, controlled cognition). More recently the effects from aversive environments on resultant human performance are suggested by some to be moderated by perceptions about the task and the personal significance of performing the task (Jones, 1984). This conceptualization of task-percept based performance outcome is reminiscent of Neisser’s (1976) description of the human as actively and flexibility functioning in terms of a perceptual cycle. Niesser’s dynamic view of cognition and outcome performance is said to hinge on a person’s schema, or a mental representation of their beliefs, and interpretations (or percepts) about the external environment.
The schema that the person develops about the environment, in turn guides information search, action, and task-based performance, which then again modifies the person’s schema in a continuous cycle. Within this view, the control of behavior, and furthermore, the results of any experimental analyses regarding human performance are highly contingent on the dynamic interplay between one’s perception/behavior, task, and environment rather than a mere fixed mechanistic explanation such as resource depletion. The value of ‘schemas’ and the continuous ‘dynamic interplay’ of human, task, and environment is also similar to the aforementioned Gibson’s (1979) ecological perspective, where information is structured by the environmental affordances or the opportunities and threats it provides are interpreted and acted on.

The notion that humans continuously, actively, and flexibly pursue goals within aversive and complex environments is traditionally not a factor of study within most applied experimental results. Alternatively, human performance is often interpreted as resulting from a pool of resources, or abilities to attain or continue effectively on an experimental task. And when a stressor is added to the environment or task, it is traditionally suggested to deplete resources/abilities, as explained solely by resultant task performance. Interpretive problems arise when these mechanistic approaches (resource theories, information processing models, computation metaphors) are used to describe the results of experiments where human performance is suggested to have been the effect of the aversive (or stressful) condition. The primary goal of experiments that employ aversive conditions is to predict the human’s performance simply by ‘type’ (deactivating or activating) and ‘strength’ of the stressor(s) in the environment. The problem is that while this mechanistic explanation may explain a trend in experimental performance data, it does not shed light on the operations functioning in the symbiotic black box that occur from the specific subject by task by environment interactions. For
example, a simple mechanistic explanation is often interpreted (e.g., lack of resources, inability to perform) without any effective support other than task performance and experimental condition parameters alone. Further, this symbiotic black box explanation is erroneously generalized to operational settings where the performance of a real world operator is predicted based on the performance of those in the studies.

A perspective offered by Matthews, Davies, Westerman, and Stammers (2000) describes performance psychology as requiring consideration of integrated formal models of cognitive psychology along with depiction of factors of stress and individual differences. And may be distinguished from cognitive psychology in at least four respects: research aims, concern with “context”, use of multiple levels of explanation, and applied relevance. Explaining performance then requires both a model of competence (resources and the capacity of the mind to perform) and an understanding of how the expression of that competence in observable behavior varies with factors such as stress and voluntary intentions. This allows for the inclusion of emotional and motivational factors to offer explanations of the effects of factors such as anxiety, fatigue, avoidance, and interest in the task. This view supports the notion that the person is an active agent whose wishes and strategies shape their objective performance and subjective experience of task environments. Cognitions then are seen as operating within a wider context, including the physical and social environment, and intra-personal factors such as emotion, motivation, and personality. Suggested herein is that more than one level of human performance needs to be included. The mechanistic, neurophysiological, psychophysical, and emotional/motivation factors are all necessary for any adequate measure to be valid and used to describe and diagnose dynamic cognitive activity within complex environments or the symbiotic concept between man-machine performance.
This project intends to reveal how the common neglect of factors in the symbiotic black box can lead to drastically different interpretations of performance and that the lack understanding of the subject by task by environment interactions that fostered the experimental results will be theoretically different than those which could occur in the real-world. Specifically, this paper outlines a potential dilemma, a “task-avoidance” that may occur in experiments where an aversive condition is presented. The phenomena and effects from task-avoidance are neglected. This is because most task-based performance results (e.g., aversive condition results in significantly decreased performance) are described solely as a reduction in resources or inability to perform, as opposed to an avoidance of the task when stressful or aversive conditions are present. With task-avoidance present resources are not unused because they ‘cannot’ be, but because they were not ‘desired’ to be used. The human’s level of task avoidance (which also results in decreased performance) during experiments is contingent on environment characteristics (e.g., stressors), perceptual and behavioral elements (e.g., goal changes, motivation, effort extended) and task interactions (e.g., importance, contingencies, significance).

In traditional psychological experiments this factor has been recognized and applied to the interpretation of results. For example, Kanfer, Ackerman, Murtha, Dugdale, & Nelson, (1994) described that there is considerable evidence suggesting that adoption of more ambitious goals tends to be associated with superior performance. Delineating that point that goals are a function of the perceptual / behavioral component and can modify any relation between task and performance. Similarly, Guion (1997) suggests that higher-order performance is moderated by ‘effort expended’ and refers to the consistency of effort, expending extra effort as needed and persistence of working even under adverse conditions. Effort expended is a function of perceptual and behavioral elements as well as task interactions and can be independent of
motivation or goal changes. Most recently in the field of human performance research, it has been suggested that performance needs to be viewed from three distinct standpoints: the aims and goals of the performer, the formal rule-based processing which supports performance, and the neural hardware underlying symbolic computation (Matthews, Davies, Westerman, & Stammers, 2000). They further describe stress as a variable that affects the willingness, as well as the resource capacity aspect of performance. Modeling this interactive process, however, has been difficult to accomplish especially when its elements should incorporate aspects of generalizing, validating, and transferring research findings. One preliminarily insightful attempt toward understanding the symbiotic black box comes from Lazarus and Folkman’s (1984) transactional model of stress which emphasizes the human’s ‘perceptual and behavioral’ active attempts to manage and cope with external demands contingent on their significance to the individual.

Many theories of human motivation over the long term or life cycle have been successful at explaining motivational influences on life processes. Unfortunately, there are few theories or models of task based performance or real time performance dynamics that include the role of motivation as a major component. Studies in recent human factors, cognitive, and performance psychology tend to apply the more mechanistic, non-control, and reflexive perspectives of experimental results of performance in hopes to attain some solid functions for mechanistic prediction. As we have discussed, and plan to address in this experiment, motivation and its lower order elements and contingencies (e.g., goal changes, personalities, efforts expended, priorities, attention) are a major factor in the outcomes of human performance in experiments, and results need to be adapted to the experimental versus real world changes in motivations that occur. For example, while experimental task-based results may indicate that stress causes lower
performance in a flight setting, the real-world counterpart situation presents stress that is contingent on the performance (e.g., fear of death) thereby increasing motivation to perform. Results from lab experiments, in this case, cannot be generalized to real-world counterparts due to aversive/stress conditions and the possibility of participant task-avoidance from differing goals and motivations. Wickens and Holland’s (2000) reiterate this point and describe that when stress is evident, meaningfulness of the task will influence performance and moderate the effects of stressors. In the real world there is hardly ever a task and stress situation where the stress itself is not contingent on the operator’s performance. It is almost always the case that in task-based situations, stress will increase as task-performance decreases and thus performance results in a stress-task experiment reflect the meaningfulness of the task and the willingness or motivation of the individual to perform the task under stress or other distractions.

The motivational manipulation of payment contingency may be used to provide potential solutions to the task-avoidance problem in lab-based tasks under stress. This project will examine the potential for measuring, diagnosing, and manipulating a participant’s level of task-avoidance in lab-based task and stress performance settings. The theoretical basis for manipulating specific motivational characteristics of the task environment will be further discussed.

Human goals and motivations in real-world stress-performance scenarios are constantly present. Unfortunately, stress and operator task performance experiments often neglect, with conscious intent, the influence of these covert human responses and thus any change in performance as a result of goals and motivational changes in the human. With almost every real world stress-performance situation there is an element of motivation or goal to succeed in the task at hand (e.g., life or death, employment), whether the stress is contingent on the task or not.
For this reason, it is crucial that any stress-experiment replicate similar motivations in the human in order to observe more similar performance results within aversive conditions. Otherwise, differences in performance will most likely be due to differences in directed energy toward the task or task-avoidance and thereby cannot provide the experimenter insight to the operator’s ‘ability’ or available ‘resources’ to perform the task.

By eliciting competitive and goal oriented characteristics of an individual, within a meaningful context, the arbitrary experimental task is no longer is a task, but an opportunity to compete and acquire status or payment. The DoD is spending millions of dollars in order to develop specific features and characteristics of ‘technologies’ in task-performance environments that can facilitate operator performance (e.g., immersiveness, sound effects, graphics). The project is expected to provide evidence that by manipulating the mentality of the operator toward the task can analogously improve performance. This operator-oriented approach is strategically taking advantage of the natural evolutionary drives of the human that are inherent and covert in order to optimize performance in arbitrary-task based aversive situations. While ‘payment’ per se, may not apply to most aversive real-world task operations (i.e., the control of an aircraft going down) in which the stress itself enhances motivation, it provides a good experimental platform to foster the similar element of motivation in the participants (e.g., university students) often used by applied experimental and human factors psychologists, and generalized to the real-world (the ecological conundrum).

**Measuring, Diagnosing, and Modeling Participant Control**

Many inappropriate conclusions have been drawn because of ignorance of fundamental measurement properties and of psychometric principles. (Referring to subjective measures of workload, Nygren, 1991)
Performance measures, indices, and models are often solely selected based on the experiences of the researcher and/or as a function of the practical constraints of the experiment (Kantowitz, 2000). Unfortunately, when attempting to measure and diagnose situations where stress is a factor, ambiguity is always an issue. For example, while stress, fatigue, and workload are often measured as authentic factors, they have been shown to be biobehaviorally similar and have similar effects on performance (Gaillard, 2001). It is therefore extremely difficult to parse out and explain the mechanisms or mental variables underlying human performance results. Theory and in depth models are now becoming essential for understanding the various constructs underlying the performance output in experiments. Unfortunately, most measures of operator performance still define output alone, referring to operator-system interactions as the traditional black box and do not address what is happening within the box.

Part of the ambiguity in stress-task-performance can be seen in studies where performance can be interpreted as a result of distraction or attentional narrowing (an optimizing effect) depending on how the researcher defines the experiment and interprets the results. For example, it has been well documented that stress produces a perceptual and attentional tunneling that degrades attention-related performance. However, while some report the phenomena as a stress-related distraction, others describe it as facilitating performance when focused attention is the goal and desired. Houston (1969) documents a case in which the presence of noise stress acted to improve rather than hurt performance on a stroop task. This suggests that the stressors effect on perceptual tunneling is not simply defined by a reduction in the attentional spotlight, so that peripheral stimuli are automatically filtered. Rather, the filtering effect seems to be defined by “subjective importance or priority”. Attentional performance on tasks with high subjective importance can be unaffected (no task-avoidance), and sometimes perceptually enhanced.
(through arousal), whereas those tasks or stimuli subjectively rated lower in priority are filtered or unattended (task-avoidance) (also see Broadbent, 1971).

Due to the complexity and lack of definitive operationalization of stress there exists the need to evaluate the effects of stress on individuals in context (Hancock, Flach, Caird, & Vicente, 1995). Stress then may be interpreted as an experience that deviates both physiologically and psychologically from the normative state of the human system cognitively which may or may not affect performance because of adaptation/coping and suppression enforced consciously or unconsciously by the individual. In this respect the elements of the stress process that might be measured is the functioning of the person in mediating the effects of stress (Hockey, 1983). However, in determining the mediating of stress effects poses the age-old question of “is mediating psychological (a conscious intent, due to motivation or survival) verses physiological (unconscious reaction) or dynamic simultaneous interplay of both in which case a broad-band approach, or one that addresses multiple stressors and multiple responses in combination with a descriptive model should be implemented in measuring the stress process.

In Hancock and Warm’s, (1989) model of stress-task-performance, the performance changes resulting from deviation from the zones of optimality, could in fact be due to operator control as opposed to mechanistic explanations. Covert and control oriented factors such as motivation changes, controlled changes in effort extended, or other covert task by subject by environmental interactions will modify and mediate an operators usage of available resources thereby altering the performance results expected to come from resource use. Extended cognitive and physical resources then may be viewed as a hypothetical and un-diagnostic heuristic.

There is a plethora of literature and substantial models of processes such as human motivation and behavioral performance. Expected then, is that future models or stress-task-
performance will apply theory of more covert human responses to task based situations, reducing current gaps in mechanistic models, and supporting a much needed intellectual evolution of human factors and performance related research. Diagnosing task-avoidance in experimental environments can provide insight on previously unknown interactions such as cost-benefit tradeoffs in task-importance verses environmental constraints. However, the analysis has to be conducted strategically and with a proper theory of both overt and covert interactive responses in the experiment.

Currently there are existing measures of task-engagement (e.g., Peccinenda, & Smith, 1996); they are solely derived from changes in physiological indices such as electroencephalography (EEG) and skin responses. Interpreting physiological indices such as EEG can be ambiguous when it comes to cognitive states, as the output is ill defined from constant motion. There are many cortical feedback loops and interactions that self-amplify in the brain, resulting in a more event induced chaotic patterning of cortical neurons and any attempts to establish Newtonian causal sequences are thereby suggested to be invalid (Newman, 1995). Even with real-time monitoring of array states of an individual, unanswered questions remain as to what the human function the physiological output is providing. For example, when interpreting from valid psychophysiological indicators of stress (see Lampton, Bliss, & Morris, 2002) in order to determine stress levels associated with a particular stressor, the changes in state may result from unforeseen factors. One interpretation may be that the physiological indicator is actually revealing physiological “degradation” in cognitive resources due to the stress however an alternative explanation is that output is “shifting” of cognitive resources in order to make more optimal use during the stress. The changes observed may indicate that an individual may be “choosing not to perform” in order to reserve resources under stress (a task-avoidance) rather
than shift them. Another interpretation may be that the results reflect an active “suppression” of
the stress. While the latter may be the most direct indicator of the stress if we consider that more
suppression is needed as a function of higher levels of stress.
CHAPTER THREE: EXPERIMENT ONE

Introduction

The purpose of this experiment was to determine if participant performance on a visual discrimination task was differentially affected by white noise at 85 decibels and/or restricted time to respond (time pressure). Ambiguity is prevalent within stress and human performance literature (Hancock & Warm, 1989) possibly because of the tendency in applied experiments to pursue one-shot studies aimed at determining the effects of the input (the stressor) and the output (human performance), while the characteristics of the throughput (e.g., stress perceptions, motivations, individual differences, adaptability, goal orientation and tolerance) are relatively rarely considered, measured, or discussed (see Matthews, 2001). Due to the neglect of cognitive throughput factors findings are rarely replicated among stress-based human performance research. It is therefore necessary to initially identify performance and cognitive factors affected by the noise and time-pressure in this environment.

The ability of an individual to adapt to noise is not an all or none phenomena. It is expected to depend predominantly on individual differences in goals and perceptions of the situation and context. These factors vary extensively between each seemingly similar experiment thereby making replications difficult to obtain. In general, white noise is suggested to act in a similar manner as other stressors by affecting human output or performance on a wide variety of tasks. It has often been the case that white noise produces errors in order to influence speed of responding. However this increase in speed is usually accompanied by diminished task performance (see Matthew, Davies, Westerman & Stammers, 2000 for a review). Jones (1984) suggests that noise influences performance by disrupting the participant’s ability to control and
compensate for tradeoffs between speed and accuracy.

As mentioned previously, the way that participants perceive the features of the setting in which the noise is presented accounts for the likelihood, and how noise will affect performance. For example, Numi and von Wright (1983) demonstrated that participants high in state anxiety or anxiousness tend to be disrupted by noise more than those who were not. While that is a general statement, the task used was specific to semantic memory. There was nothing mentioned of any expected similarities among the semantic memory task and other types of tasks. Milosevic, (1983) on the other hand found no effects of loud noise on performance of a vigilance task. In fact there are some tasks and experimental settings where white noise can actually improve performance compared to no noise control groups (Davies & Jones, 1985; Jones & Broadbent 1987). It is therefore suggested that physiological measures, performance trends, and subjective reports concerning the effects of noise generate a highly complex and idiographic outline pattern.

Due to the varied findings among the noise and human performance literature, the first step of the present work is to capture the effects of the white noise at 85 decibels on the task, outlined in the following section. Further work will be carried out in experiment two that involve mapping the noise effects, cognitive states, and voluntary control over time. It is crucial, initially, to investigate the nature of the output and performance effects that exist in conditions specified in this study. This is in order to eventually define strategies adopted by observers to counteract the influence of noise.

Findings by Smith and Jones (1992) suggest that noise tends to exert little or no effect on sensory functions such as visual acuity, contrast sensitivity, dark adaptation, and accommodation, and motor responses. Since the overall goal of this work is to determine an effect of potential voluntary control of the participant, a visual discrimination task was chosen in
order to attain a small effect size. Thus only the most sensitive components of the phenomena can be identified for further test, modeling, and development.

The initial two hypotheses suggest that noise and time pressure have a significant effect on the dependent variable “overall percent correct” (OPC). OPC represents the percentage of correct responses to pairs of images out of the number of image pairs attempted within all three allotted five-minute task periods. More specifically:

- Independent variable “white noise”, presented continuously at 85 decibels, will produce lower OPC performance on the overall fifteen-minutes of visual discrimination task time.
- Independent variable “time pressure”, or only allowing 2-seconds to respond to each image pair, will produce lower OPC performance on the overall fifteen-minutes of visual discrimination tasks than the traditional 4-second response allowance.

The following hypotheses theorize that there exists confounds in traditional stress research paradigms. Participants may be avoiding, or be distracted in stress-based research when there is no reward or personal goal to achieve. This would suggest that many previous research findings among stress experiments should be re-assessed for their actual utility in making generalizations to real world conditions where operators have performance goals despite stress problems.

- Participants who were told and provided payment contingently based on their performance would produce higher OPC performance than those who were not.
- There will be significant differences between the stress conditions (noise and time
(pressure) and analogous non-stress conditions as discussed in the first two hypotheses. However, the groups that had identical stress conditions but with payment contingency, would not differ from the higher performing no-noise and no-time pressure non-stress conditions.

The hypotheses were tested using the experimental design represented below (see Table 1).

### Table 1. The 2 X 2 X 2 Between-Participant Research Design Used in Experiment One.

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### Experimental Methods

### Experimental Participants

Participants used in the first experiment included undergraduates, graduates, and staff members of the University of Central Florida (n = 80). The mean age of participants was 23 and the range was from 18 to 45. Some participants received extra credit for current courses while other participants received payment for their participation depending on condition assignment.
Experimental Apparatus

A visual tele-binocular was used to deliver the Snellen acuity test to all participants. Skin conductance and peripheral skin temperature were recorded using surface electrodes. The electrodes were secured with Velcro straps on the palmer side of the second, third, and fourth fingers of the non-dominant hand. The signals were sampled at 32Hz using the Procomp-plus signal amplifier developed by Thought Technology, Ltd. Biograph biofeedback software Version 2.0 also developed by Thought Technology, Ltd. was used to collect the real-time skin conductance and peripheral temperature data throughout the entire session. Specific data within time intervals corresponding to a participant’s start and stop times for each task were reported for each participant for future analyses.

A Cedrus RB-620 series response keypad was used by the participant’s to input each response during the visual discrimination tasks. The Cedrus RB-620 response pad is accurate to the millisecond of user input. A standard dell soft-touch keyboard was used by the participants to enter numeric data corresponding to the electronic DSSQ and CIPT questionnaires.

Musician’s quality super-quiet headphones developed by Firth were used to deliver the white noise (where the amplitude is constant throughout the audible frequency range as produced by a random frequency generator) at 85 decibels on a C weighted scale, for inducing an aversive environment (expectedly). Decibel (dB) represents the intensity or power ratio of a given sound relative to a reference level. The references level expressed in terms of the pressure of the root mean square sound wave, so that intensity levels are expressed in terms of the sound pressure level (SPL), for example 80 dB (SPL). Each increase of intensity of 10 db, for example an increase from 60-70 dB (SPL) approximately doubles the subjective loudness of sound.
The experimental task, task instructions, feedback, white noise and Dundee Stress State Questionnaire were all delivered via the Dell Dimension 8200 personal computer. The tasks, instructions, feedback, white noise, and Dundee Stress State Questionnaire were programmed using Presentation, software currently under development by Neurobehavioral Systems, Inc. for use in experimental settings. The development of the task scenarios was completed using the Presentation software in combination with additional computer programming via scenario description language (SDL) and program control language (PCL). The programs were also designed to electronically record and save participants’ responses in output log files. All output files from both the physiological and experimental software resulted in eight different data files per participant.

**Experimental Measures**

**Objective Task Performance Measures**

Images for the visual discrimination task were presented in pairs and participants were asked to continuously respond to them by pressing a button to indicate “same” of “different”. The images were randomly presented in pairs. The images used in the first five minutes of task time were titled “hypno” and can be seen in Figure 1. The images presented for the second five-minute interval were titled “walk” and can be seen in Figure 2. The images presented for the last five-minute interval were titled “smile” and can be seen in Figure 3.

Analyses for objective task performance included four primary dependant variables; i)
Mean Speed (MS), was defined as the number of image pairs attempted across the five-minute task segments, ii) Mean Correct (MC), was defined as the number of correct responses across the five-minute task segments, iii) Percent correct (PC) was defined as the ratio of correct responses by total number of images attempted within a specific five-minute period of time (mean correct/mean attempted, and ix) Overall percent correct (OPC) which was defined as the PC over the entire duration or average across all three five-minute intervals.

Figure 1. Images titled "Hypno" presented randomly for the visual discrimination task.

Figure 2. Images titled "walk" presented randomly for the visual discrimination task.

Figure 3. Image titled "smile" presented randomly for the visual discrimination task.
Self-Report Measures

A demographic questionnaire was used to gather information regarding participant gender, age, visual acuity, hours of work and school, caffeine intake on the day of the experiment and provided a brief question about their alertness and energy level. Both the full version and some validated subscales of the Dundee Stress State Questionnaire (DSSQ) (Matthews, Campbell, & Falconer, 2001) were used to collect mood, motivational, and cognitive state information (appendix A). The Coping Inventory for Task Stress (CITS) (Matthews & Campbell, 1998) (appendix B) and Farmer and Sundberg’s (1986) Boredom Proneness Scale (BPS) were also used (appendix C). Ray’s (1979) Achievement Motivation index (AMI) (appendix D), and a Competitiveness Scale (CS) (Laner, 1986) (appendix E) were also used to collect data about participant voluntary control characteristics.

Physiological Measures

A visual tele-binocular was used to deliver the Snellen acuity test to all participants who reported non 20-20 or unknown visual acuity. Skin conductance and peripheral temperature data were collected over the entire computer-based part of the study in order to minimize intrusive on and off processes. Out of the continuous physiological data, four specific time intervals were exported for analyses, i) the first one and a half minutes during the pre-task practice session for a baseline ii) the second iii) the third and ix) the fourth five-minute interval during which the task only was being performed. The physiological data were also unobtrusively and continuously
collected during the pc-based questionnaires but were not exported for any data uses in this study.

**Procedures**

A paper based informed consent and a demographic questionnaire was administered to entering participants. Participants were then randomly assigned to one of eight conditions (see Table 1). The BPS, AMI, and CS were administered via paper questionnaires. Following the questionnaires the participants were asked to place their non-dominant hand on a protruding ledge with the palmer side of the hand facing upwards. Velcro straps were used to wrap the skin-conductance electrodes around the tips of the second and fourth fingers as well as the peripheral skin temperature indicator on the third finger. The participants were given verbal instructions that they should attempt as many pairs of images but as accurately as possible. Participants in the payment contingency conditions were additionally informed that they would start with five dollars and the amount of money that they could make depended on their overall task average (number correct divided by number of trials attempted) on the tasks. They were also asked to work as quickly and as accurately as possible.

Poulton (1978, 1979) suggests that loud noise impairs performance by masking the helpful cues from the task being performed, which provided feedback concerning the accuracy of performance. Therefore, both the practice and the main tasks used herein provided auditory feedback (a loud beep for correct, or a gonk sound for incorrect) for each response of the participants. The headphones were placed on their head to a comfortable fit. Then the physiological recordings were started and times were logged before the practice session started.
The practice session also provided examples of all three of the images and written instructions for how to respond.

After the instructions were presented via computer, the participants were given one and a half minutes to practice the task by pressing the “same” or “different” buttons for each of the three images that were used in the coming sessions. This practice session was also used to collect baseline physiological data as well as present the electronic version of the DSSQ by which the participants responded using the keyboard’s number pad. After this first practice session, their data were recorded and the next five-minute task session was started for the series of image 1. The simultaneous pairs of Image 1 were presented and the participants responded “Same” if the images were identical and “Different” if the images were not exactly the same for a period of five-minutes. The subscales of the DSSQ were then electronically presented again before the next session started. After the participants completed the questions, the series of image 2 pairs were presented for a corresponding five minutes and again they completed the DSSQ subscales. Finally, the pairs of image 3 were presented for a final five-minutes, after which they completed the DSSQ subscales a final time. The conditions and the design of experiment one is as represented in Table 1.
Experimental Results

Main Effects

Overall Task Average

A univariate ANOVA revealed that there were significant main effects for all three independent variables on the dependent variable of OPC, however, none of the interactions reached significance on OPC. Levene’s test for homogeneity of variance was also within acceptable limits with $p = .436$. As shown in Figure 4, the main effect for noise revealed that participants who were exposed to white noise at 85 decibels, on the C weighted scale, ($M = 88.50, SD = 4.38$) had a significantly higher OPC than those who were not exposed to the noise 85 dB, C weighted scale, ($M = 85.81, SD = 4.23$), $F(1, 72) = 9.56, p = .003, SE = .643$, and the effect size was moderate with $\eta^2 = .117$. 

As shown in Figure 5, the main effect for the independent variable “time pressure” revealed that participants who were given a maximum of 4-seconds to respond to each pair of images scored significantly higher on OPC ($M = 88.90, SD = 4.23$) than those who were limited to 2 seconds per pair of images ($M = 85.41, SD = 4.07$), $F(1, 72) = 16.03, p < .001$, and the effect size was moderate with $\eta^2 = .182$. 

*Figure 4. Main effects of noise absent verses present on OPC.*
Figure 5. Main effects of 2-second versus 4-seconds of response time on OPC.

As shown in Figure 6, the main effect for the independent variable payment contingency revealed that participants who understood that they would be given payment with the amount based on their performance scored significantly higher on OPC ($M = 88.10, SD = 4.13$) than those who participated voluntarily or for extra credit in class, not contingent on their performance ($M = 86.21, SD = 4.68$), $F(1, 72) = 4.72, p = .033$, and the effect size was small to moderate with $\eta^2 = .062$. 


A MANOVA was used to determine any effects of the three independent variables time pressure, noise, and payment contingency on participants’ mean speed (MS) and mean correct (MC). The MANOVA revealed that there were significant main effects for noise \(F(2, 71) = 5.37, p = .007, \eta^2 = .131\), and time pressure \(F(2, 71) = 37.93, p < .001, \eta^2 = .517\), but only approached significance for payment contingency \(F(2, 71) = 2.60, p = .082, \eta^2 = .068\), on the MS and MC dependent variables combined.

Further univariate analyses revealed that the independent variable “noise”, where the absence of noise \((M = 578.83, SD = 75.48)\) only approached significantly more than the presence of noise \((M = 560.08, SD = 86.83)\) on the separate dependent variable MS, or total pairs or
images attempted, $F(1, 72) = 1.91, p = .171, \eta^2 = .026$. The absence of noise ($M = 496.03, SD = 60.34$) was not different than the presence of noise ($M = 495.38, SD = 77.45$) on the dependent variable MC, or total correct responses, $F(1, 72) = .002, p = .96, \eta^2 < .001$. The independent variable “time pressure,” was the only one of the three independent variables to yield significant differences on the separate dependent variable MS, $F(1, 72) = 63.93, p < .001, \eta^2 = .470$, as well as MC, $F(1, 72) = 34.19, p < .001, \eta^2 = .322$. As shown in Figure 7, participants who were in the 2-second condition, ($M = 623.63, SD = 41.59$), responded faster than those who were in the 4-second condition, ($M = 515.23, SD = 75.28$).

![Figure 7. Mean Speed on 2-second versus 4-second conditions.](image)

Interestingly and unexpectedly, as shown in Figure 8, participants in the 2-second condition also had significantly more correct responses, or mean correct ($M = 533.78, SD = 39.92$) than those in the 4-second condition ($M = 457.63, SD = 71.22$).
Figure 8. Mean correct responses of the 2-second versus 4-second conditions.

The independent variable “payment contingency”, only approached significant differences between the Yes ($M = 559.45$, $SD = 80.87$) and No ($M = 579.45$, $SD = 81.68$) groups on the separate dependent variable MS, or total pairs attempted, $F(1, 72) = 2.18$, $p = .144$, $\eta^2 = .03$. The independent variable “payment contingency” also produced no differences on MC, $F(1, 72) = .406$, $p = .526$, $\eta^2 = .006$. Participants who were in the No condition, ($M = 499.85$, $SD = 70.13$), did not produce more correct responses than the Yes condition, ($M = 491.55$, $SD = 68.46$).
Planned Comparisons

Overall Percent Correct

As shown in Figure 9, an initial planned comparison revealed that participants in the noise absent condition ($M = 87.64, SD = 4.62$) scored significantly higher than those in the noise present condition ($M = 84.78, SD = 4.39$), on OPC, $t(57) = -2.09, p = .041$. Effect sizes were calculated using the formula for eta squared (see Kiess, 2002) and for the absent versus present condition and was moderate with $\eta^2 = .07$. A second planned comparison showed that the noise present condition discussed previously did not significantly differ from the absent with contingent payment condition ($M = 86.84, SD = 3.88$) on OPC, $t(57) = 0.58, p = .56$, with $\eta^2 = .006$.

![Figure 9. Planned comparisons of noise absent, present, and absent payment contingency conditions.](image)

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As shown in Figure 10, an initial planned comparison between the time pressure conditions revealed that OPC was significantly lower for the 2-second condition ($M = 84.410$, $SD = 3.3866$) than the 4-second condition ($M = 88.01$, $SD = 5.16$), $t(57) = -2.57$, $p = .013$. The calculated effect size was moderate with $\eta^2 = .10$. A second planned comparison between the aforementioned higher scoring 4-second condition ($M = 88.01$, $SD = 5.16$) and a third, 2-second with pay-contingency condition ($M = 86.41$, $SD = 4.53$) revealed no significant differences on OPC, $t(57) = 1.14$, $p = .259$ with $\eta^2 = .022$.

![Figure 10](image-url)

*Figure 10. Planned comparisons between the 2 and 4-second time pressure conditions on OPC.*

**Effects of Noise on the Separate Images**

A planned comparison revealed that participants who were in the noise condition ($M =$
84.60, SD = 5.84) had significantly higher percent correct scores on the task than those in the no-noise condition (M = 80.90, SD = 5.73) on image 1, which was also presented at time 1, t(57) = -2.22, p = .031, with η² = .079. A second comparison revealed that those who were in the noise condition mentioned previously did not score significantly different than those in the no-noise condition with contingent payment (M = 83.30, SD = 4.09), t(57) = 0.778, p = .440, with η² = .010.

A planned comparison revealed that participants who were in the noise condition (M = 93.20, SD = 3.85) had significantly higher percent correct scores on the task than the no-noise condition (M = 90.10, SD = 4.68) on image 2 which was also presented at time 2, t(57) = -2.179, p = .031, with η² = .077. A second comparison revealed that those who were in the noise condition mentioned previously did not score significantly different than those in the no-noise condition with contingent payment (M = 91.50, SD = 4.90), t(57) = 0.88, p = .383, with η² = .013.

A planned comparison revealed that participants who were in the noise condition (M = 85.70, SD = 5.28) only approached significance from the no-noise condition (M = 83.35, SD = 5.85) on image 3 which was also presented at time 3, t(57) = -1.351, p = .18, with η² = .031. Likewise the noise condition did not score significantly different than the no-noise with payment contingency (M = 85.25, SD = 5.35).

**Effect of Time Pressure on the Separate Images**

A planned comparison revealed that participants who were in the 2-second condition (M
were not significantly different on percent correct (PC) scores than the 4-second condition ($M = 84.05, SD = 6.92$) on image 1 which was also presented at time 1, $t(57) = -1.434, p = .157$ with $\eta^2 = .047$. A second comparison revealed that those who were in the 4-second condition mentioned previously also did not score significantly different than those in the 2-second condition with contingent payment ($M = 82.30, SD = 5.29$), $t(57) = 0.965, p = .339$, with $\eta^2 = .016$.

A planned comparison also revealed that participants who were in the 2-second condition ($M = 89.90, SD = 3.21$) had significantly lower PC scores than the 4-second condition ($M = 93.40, SD = 5.0$) on image 2 which was also time 2, $t(57) = -2.536, p = .014$, with $\eta^2 = .10$. A second comparison revealed that those who were in the 4-second condition mentioned previously also did not score significantly different than those in the 2-second with contingent pay condition ($M = 91.55, SD = 4.67$), $t(57) = 1.341, p = .185$ with $\eta^2 = .03$.

A planned comparison revealed that participants who were in the 2-second condition ($M = 82.4, SD = 4.91$) had significantly lower PC than the 4-second condition ($M = 86.65, SD = 5.63$) on image 3 which was also presented at time 3, $t(57) = -2.408, p = .019$ with $\eta^2 = .09$. A second comparison revealed that those who were in the 4-second condition mentioned previously did not score significantly different than those in the 2-second with contingent pay condition ($M = 85.35, SD = 6.16$), $t(57) = 0.736, p = .464$, with $\eta^2 = .009$. 

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Experiment One: Discussion

Noise

The results of experiment one suggested that 85 decibels of noise on a C weighted scale within this experimental context produced an increase in overall percent correct on a visual discrimination task. Overall percent correct was calculated by the average or ratio of correct responses over attempted trials. For example, a participant may have had 680 correct responses out of 720 attempts. They had a total of fifteen-minutes (in 3, 5-minute sessions), to attempt as many trials as possible (also used as speed). Therefore the computation of number correct divided by number of trails attempted across 15 minutes was used for determining the overall percent correct, the primary dependent variable in this study.

The results of this study found an effect which coincides with findings where loud white noise actually increased performance (Davies & Jones, 1985; Jones & Broadbent, 1987). Although the superior OPC performance of those who experienced 85dB (C) of noise was an unexpected finding, it has some support by previous research. For example, Smith and Jones (1992) suggest little or no effects of noise on sensory functions such as acuity, contrast sensitivity, dark adaptation and accommodation. They even extend their suggestions to include no noise effects on participants’ motor responses to visual stimuli.

Considering the aforementioned more traditional “arousal theory”, one explanation is that noise acted as a stimulant on the participants in this study thus leading to better performance. In contrast, the group who received no-noise performed significantly worse. Again, arousal theory would explain these results by painting the participants as those who were under-stimulated.
individuals and therefore became bored with the task at hand. This is a common finding among lab-based tasks that require participants to sustain their attention to an arbitrary task over intervals of time. In order for arousal theory to be considered a solution within this experiment, it would have needed to last for a longer duration requiring human performance. A case of under-stimulation would then have shown a decrease in performance across time (under stimulated participants by boredom). On the other hand the participants who received the noise and were expectedly in a state of stimulation might have shown an adaptation over time. While they would have initially had a higher level of performance at the onset of the task, habituation literature indicates that they would adapt and possibly level off, eventually yielding more moderate performance levels as participants become adapted to the continuous 85dB noise.

Noise also tends to produce brief periods of inefficiency in relatively simple reaction time. Tasks that require continuous responding should also increase error rates throughout performance (Jones, 1983). It is often the case that noise produces an increase in number of gaps (or non responding) but no overall differences among correct responses (Davies & Jones, 1985). Both errors and gaps tend to increase with time on task being more frequent towards the end of the task. Since this study only used the averaged performance correct scores across three, five-minute intervals, it is not represented whether noise produced similar gaps in responding.

**Time Pressure**

An even larger effect size was found for the differences within the time pressure conditions. Those who were in the 4-second condition, who had exactly 4-seconds to respond to each pair of stimuli presented over the 15-minutes, performed better on their overall percent
correct than those who were limited to 2-seconds. This was a predicted result due to the aforementioned visual discrimination literature suggesting that these tasks are easier to perform with longer periods of time to observe the images. Also, as expected the effects of greater time pressure by 2-seconds led to higher mean speed of responding than the 4-second group, even though both groups were instructed to perform as fast and as accurate as possible.

Alternatively, there was a rather perplexing and unexpected result that deserves further attention. While the increased time pressure (2-seconds to respond) condition led to significantly greater speed (more trials responded to), they also scored significantly higher in number (not ratio) of correct responses. A deserving question is: how the condition that scored higher on speed and correct responses could also significantly score lower on overall percent correct (number correct divided by number attempted)? An immediate explanation may be that those participants had to attempt more trials and thus were able to obtain more correct responses because of the extra opportunities for chance. This suggests that they did not employ strategic shifts in the speed-accuracy tradeoff. While this explanation leaves much to be desired, further research which will be discussed in following study which may lead to alternative explanations, as these conditions will be explored over time.

The results the effects of noise and time pressure in this study, along with other previous ambiguous research on the topics, suggests a dramatic need to further establish taxonomies, and models that involve stressors as separate attributes from the stress experience. Furthermore, the attributes of the task-environment as well as the attributes of the participant, cognitive attributes of the participants under study should be modeled and described in a dynamic and interactive fashion as shown in the conceptual representation of Figure 11.
Figure 11. Interactive model of the stress experience

If the results from research are to reach their intended level of generalization, models and taxonomies need to address the combinations of these diverse attributes. It is all too often that applied research draws premature conclusions and sacrifices among ecological validity that ultimately leads to embarrassing error in prediction.

Payment Contingency

The second part of this experiment was to examine the efficacy of the depleted resource theories on overall percent correct. The under-performing “no-noise” and “time pressure” groups were then compared to identical counterpart conditions but with “payment contingency” (the opportunity for the participant to increase the amount of money he/she receives based on OPC). This comparison was performed to determine if there may be what Kantowicz referred to as a “subject by task” ecological validity problem or as suggested here, a task-avoidance among some
participants. Instead of depleted resources or the participant’s inability to perform in the stress condition, the present hypotheses and results suggest that there may be a task-avoidance accounting for lower performance, especially in aversive or stress based conditions interacting with participants who may have low interest in the task (not a task where survival or one’s job is on the line, or are highly motivated to perform).

As expected, participants in the analogous conditions who understood that they would be paid an amount of money based on their performance performed significantly higher than the identical non-paid groups. Also as expected, the payment contingency, stress condition participants, did not significantly differ from the superior performing, non-stress-condition counterparts. This suggests that performance of the no-noise group, and the pressure induced by the 2-second condition may be a function of the induction of different goals, task interest, motivational attributes and directed energy. All of which would suggest that the differences found within many traditional stressful or aversive environments may be a function of participant voluntary control. This finding reduces the likelihood of resource depletion or physiological inabilities to perform.

**Future Considerations**

The task and images used in this study were not traditional vigilance material. Often vigilance tasks utilize images that are considered rather boring such as blips, blobs, sticks, or on special occasions shapes. A traditional vigilance task requires uninterrupted sustained attention over periods of time that are traditionally longer than the three five minute segments used here. While overall the participants in this study completed fifteen minutes of task time, they were
broken into three separate segments with questionnaires in between. Such interruptions may have dispersed the vigilance effects seen in many stress and performance studies. Also vigilance studies often require that the participants only respond to specific stimuli and thus require relatively fewer responses than this study, which required a response for each set of images. The task used here required continuous responding that also presented either correct or incorrect feedback immediately. Additionally, the task used colorful and, as often verbally reported, fun images (smiley faces, walking men, and hypnotic circles). This “fun” aspect described by many, may account for the moderate to low effect sizes for overall task averages.

Although several attempts have been made to isolate the source of workload, stress, and boredom in vigilance, none currently appear to account for all the results in the literature. Differential levels of boredom are suggested as influenced by the need to focus attention and the inability to quit the task at will (Hancock & Warm, 1989; Scerbo, 1998). Explanations of the phenomena are often diagnosed as “depletion of resources” or an inability to perform due to underlying mental and physiological inabilities. The results from this experiment indicates the need for further research and explanation geared toward modeling the cognitive, and personality factors, and goal orientations across task attributes and contexts in order to provide ecologically valid solutions within various stress and human performance settings.

Further analyses completed on each image (one, two and three) in this study revealed that there may be differences in these findings across time. Image one was also presented at time one, two at time two, and three at time three. Interestingly, the group who experienced noise performed better on OPC than the group who did not experience noise (comparison 1). The other no-noise group with payment contingency performed just as well as the noise group (comparison 2). However, when identical planned comparisons were conducted separately for each image or
at each time period, the effect on OPC existed only for images one and two. The analysis on image three showed that the noise and no-noise group only approached significance while the payment contingent no-noise group remained no different than the noise group. This suggests a possible habituation to the 85db noise in which stimulation was no longer produced since images one and two were presented also at time one and two. Similarly, the time pressure conditions as described previously, replicated the planned comparisons for task average but only on images two and three, which were also presented at time two and three. This suggests that increased time pressure was not an issue for image one, or time one, but over the course of the experiment or image two/time two and image three/time three, the 2 seconds became more difficult, or induced more “disinterest in succeeding”.
CHAPTER FOUR: EXPERIMENT TWO

**Introduction**

The purpose of experiment one was to determine the direction and nature of the effects of noise and time pressure on a visual discrimination task. Based on the results of experiment one, an immediate conclusion is that noise served as a stimulant thereby producing better performance. Likewise, the payment contingency produced better performance and thus appears to act as a motivator. This finding is typically explained in terms of an arousal-theory, or stimulation based performance increase, and can be modeled simply using the traditional Yerkes-Dodson relationship. Unfortunately, this simple relationship leaves few avenues to explain goal change, operator control, and meaning. Figure 11 represents a conceptual model of the factors that need to be considered, modeled, and measured in stress experiments. A more complex conceptual model would reveal how stress and performance trends occur including the factor of time or duration of task. Before a full model of any stress-performance relationship can be made, and approach ecologically valid conclusions, main sources of data that are suggested to be absolutely necessary to obtain. 1) Behavioral sources of data which include information about an operator’s task performance, 2) physiological sources of data which provide more covert information about the nature of the stress experience employing real time data of perception and action. 3) Cognitive or as Hancock and Warm (1989) suggest “structure” data in which participants may provide information about the meaningfulness of factors and goals during the experiment, and 4) time or duration. For this reason the Hancock and Warm, (1989) adaptability model can be revered as a representative interaction model, which produces a useful foundation for deriving response indices.
Hancock and Warm’s model of operator adaptation to stress was the first known model to integrate the levels of data considered necessary for eventually developing statistical/mathematical models and algorithms. These more diagnostic and statistically applicable models are the future of human performance psychology because of the needs among the modeling and simulation community. Traditional trends in human performance psychology have been to explain or conceptualize input and output models (i.e., resource theory). Now there is the need to diagnose the environmental, task related, covert mental processes, and duration factors in order for fully diagnostic and predictive models to be developed. No longer shall a pictorial or metaphorical representation serve as much of a purpose as once intended. The degree and extent to which data interactions are diagnosed and modeled for predictive purposes provide also further clarity of the importance of “context” within applied experimental studies. This suggestion, while discussed within the introduction, is again crucial in order to provide insight about the intent of experiment two.

The Hancock and Warm (1989) model remains a representative foundation, without formulae (and rightly so), in order to remain adaptable to various and dynamic contexts, environments, and operator characteristics. It is only hoped that other researchers will recognize the foundational value of the representation and work from it to produce context specific formulae and prediction equations for future modeling and simulation tools and other resources within the multiple domains of crucial need.

Experiment one resulted in the fact that stress and human performance experiments need to take into consideration the characteristics of both the participants involved, context and the task environment in order to obtain at least some ecological validity. Also it clearly demonstrated that participant voluntary control in a stressful situation contributes significantly to a subject by
setting interactive confound. Avoidance of task conditions that include stress or aversive elements may account for more of the experimental stress-no stress effects more than previously thought. Further, studies geared toward isolating this phenomena of participant voluntary goal change and avoidance in tasks should result in complimentary measures to predict and partial out variability associated with the phenomena in future stress-task performance research. The foundational experiments herein will lead into the development of such an index of voluntary control.

For the next study, the initial hypothesis represented a manipulation check. Participants’ OPC under 2 and 4 second time-pressure conditions are expected to replicate the finding from experiment one. Specifically:

- Time pressure, or by reducing the 4-second response interval to 2 seconds, would produce lower OPC performance on the visual discrimination task.

- A third condition, the 2-second with payment contingency condition will also replicate the experiment one findings that there will be no difference between it and the higher performing 4-second condition.

This would again indicate that participants may be avoiding, or distracted by stress when there is no reward or personal goal to perform well.

The subsequent hypotheses in experiment two are to determine if the time-pressure conditions and related findings from experiment one, hold the same pattern for different sequences of image presentation. Since image two was considered the easiest image of the three, it is expected that by changing image sequences might cause a change in the voluntary control phenomena indicated in experiment one. The different sequences of images also serve to counterbalance in order to determine if there are different trends among the time-pressure
conditions that change over time or duration of the study. Sequences need to be counterbalanced in a way such that each image represented across each time interval for an equal number of participants. More specifically, the second and third hypotheses are as follows:

- The different levels of time-pressure (2-second, 4-second, and 2-second with payment contingency) would produce differences on PC for the entire time duration. Specifically, based on findings from experiment one, the 2-second with payment contingency condition is expected to increase in scores over time or duration, whereas both 2-second and 4-second may increase initially (due to learning and practice) then decrease on PC.

- Participants are expected to differ on PC as a function of the image sequence or order of presentation they were placed in. While experiment one revealed that some images tend to be easier than others, their order in which they are presented is expected to influence performance.

Table 2. The 3 X 3 mixed factorial design of experiment two.

<table>
<thead>
<tr>
<th></th>
<th>Time 1</th>
<th>Time 2</th>
<th>Time 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Second</td>
<td>n = 42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Second</td>
<td>n = 42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Second with Pay</td>
<td>n = 42</td>
<td></td>
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</tbody>
</table>
Experimental Method

Experimental Participants

Participants used in experiment two included undergraduates, graduates, and staff members from the University of Central Florida (n = 126). The mean age of participants was 23.8. Some participants received extra credit for current courses while other participants received payment for their participation depending on condition assignment. Overall there were 30 males and 96 females who participated in experiment two.

Experimental Apparatus

A visual tele-binocular was used to deliver the Snellen acuity test to all participants. Skin conductance and peripheral skin temperature were recorded using surface electrodes. The electrodes were secured with Velcro straps on the palmer side of the second, third, and fourth fingers of the non-dominant hand. The signals were sampled at 32Hz using the Procomp-plus signal amplifier developed by Thought Technology, Ltd. Biograph biofeedback software Version 2.0 also developed by Thought Technology, Ltd. was used to collect the real-time skin conductance and peripheral temperature data throughout the entire session. Specific data within time intervals corresponding to a participant’s start and stop times for each task were reported for each participant for future analyses.

A Cedrus RB-620 series response keypad was used by the participant’s to input each response during the visual discrimination tasks. The Cedrus RB-620 response pad is accurate to the millisecond of user input. A standard dell soft-touch keyboard was used by the participants to
enter numeric data corresponding to the electronic DSSQ and CIPT questionnaires.

Musician’s quality super-quiet headphones developed by Firth were used to deliver the white noise (where the amplitude is constant throughout the audible frequency range as produced by a random frequency generator) at 85 decibels on a C weighted scale, for inducing an aversive environment (expectedly). Decibel (dB) represents the intensity or power ratio of a given sound relative to a reference level. The references level expressed in terms of the pressure of the root mean square sound wave, so that intensity levels are expressed in terms of the sound pressure level (SPL), for example 80 dB (SPL). Each increase of intensity of 10 db, for example an increase from 60-70 dB (SPL) approximately doubles the subjective loudness of sound.

The experimental task, task instructions, feedback, white noise and Dundee Stress State Questionnaire were all delivered via the Dell Dimension 8200 personal computer. The tasks, instructions, feedback, white noise, and Dundee Stress State Questionnaire were programmed using Presentation, software currently under development by Neurobehavioral Systems, Inc. for use in experimental settings. The development of the task scenarios was completed using the Presentation software in combination with additional computer programming via scenario description language (SDL) and program control language (PCL). The programs were also designed to electronically record and save participants’ responses in output log files. All output files from both the physiological and experimental software resulted in eight different data files per participant.
Experimental Measures

Objective Task Performance Measures

Images for the visual discrimination task were presented in pairs and participants were asked to continuously respond to them by pressing a button to indicate “same” of “different”. The images were randomly presented in pairs. The images used in the first five minutes of task time were counterbalanced between the previously described “hypno”, “walk”, and “smile” and can be seen in Figures 1,2, & 3.

Analyses for objective task performance included four primary dependant variables; i) Mean Speed (MS), was defined as the number of image pairs attempted across the five-minute task segments, ii) Mean Correct (MC), was defined as the number of correct responses across the five-minute task segments, iii) Percent correct (PC) was defined as the ratio of correct responses by total number of images attempted within a specific five-minute period of time (mean correct/mean attempted, and ix) Overall percent correct (OPC) which was defined as the PC over the entire duration or average across all three five-minute intervals.

Self-Report Measures

A demographic questionnaire was used to gather information regarding participant gender, age, visual acuity, hours of work and school, caffeine intake on the day of the experiment and provided a brief question about their alertness and energy level. Both the full version and some validated subscales of the Dundee Stress State Questionnaire (DSSQ) (Matthews, Campbell, & Falconer, 2001) were used to collect mood, motivational, and cognitive state
information (appendix A). The Coping Inventory for Task Stress (CITS) (Matthews & Campbell, 1998) (appendix B) and Farmer and Sundberg’s (1986) Boredom Proneness Scale (BPS) were also used (appendix C). Ray’s (1979) Achievement Motivation index (AMI) (appendix D), and a Competitiveness Scale (CS) (Laner, 1986) (appendix E) were also used to collect data about participant voluntary control characteristics.

Physiological Measures

A visual tele-binocular was used to deliver the Snellen acuity test to all participants who reported non 20-20 or unknown visual acuity. Skin conductance and peripheral temperature data were collected over the entire computer-based part of the study in order to minimize intrusive on and off processes. Out of the continuous physiological data, four specific time intervals were exported for analyses; a) the first one and a half minutes during the pre-task practice session for a baseline b) the second c) the third and d) the fourth five-minute interval during which the task only was being performed. The physiological data were also unobtrusively and continuously collected during the pc-based questionnaires but were not exported for any data uses in this study.

Procedures

A paper based informed consent and an informational demographic questionnaire was administered to the participants. Participants were randomly assigned to one of three time pressure conditions (2 second time pressure, a 4 second condition, or a 2 second time pressure with contingent payment condition). Participants were also counterbalanced in order to perform
in one of three image presentation sequences (sequence 1 which presented image 1, 2 then 3; sequence 2 which presented image 3, 1 then 2; or sequence 3 which presented image 2, 3 then 1). Afterwards, the BPS, AMI, and CS were administered via paper questionnaires. Following the questionnaires the participants were asked to place their non-dominant hand on the ledge with the palmer side facing up. Velcro straps were used to wrap the skin conductance electrodes around their fingertips as well as a peripheral skin temperature indicator. The participants’ were given verbal instructions regarding the series of images and the goal of the tasks and were told to perform as fast but as accurate as possible. Participants in the payment contingency conditions were also informed that they would start with five dollars and would make more money depending on their task performance. Poulton (1978, 1979) suggests that loud noise impairs performance by masking the helpful cues from the task being performed, which provided feedback concerning the accuracy of performance. Therefore, both the practice and the main tasks used herein provided auditory feedback for each response of the participants. The headphones were placed on their head to a comfortable fit and the practice session was started. The practice session also provided examples of the images and instructions for responding.

The participants were given one and a half minutes to practice by responding “same” or “different” to some of the pairs of each of the three image sets. This session was also used to collect baseline physiological data. The electronic version of the DSSQ was presented and they responded using the keyboard’s number pad. After the first session their data were recorded and the next task session was started. The sequences of image 1, 2, and 3 were counterbalanced for each participant in order to obtain responses as a function over time. The first image was presented for five minutes while participants responded “Same” if the images were identical and “Different” if the images were not exactly the same. The subscales of the DSSQ were
electronically presented again before the next session was started. After the participants completed the questions, the next set of image pairs were presented for another five minutes and again they completed the DSSQ subscales afterward. Finally, the third set of image pairs were presented for five minutes and then again they completed the DSSQ subscales.

**Results of Experiment two**

**Main Effects Over Time**

**Overall Percent Correct**

A mixed subjects ANOVA revealed no effect of duration or time on OPC, or percent of correct responses divided by number of items attempted, $F(2, 246) = 2.10, p = .125$, with $\eta^2 = .017$. However, there were between subject main effects on OPC for each time pressure condition, $F(2, 123) = 10.56, p < .001$, with a moderate effect size, $\eta^2 = .147$. The interactions were not significant, $F(4, 246) = 0.41, p = .801$.

**Mean Speed; Number of Items Attempted**

A within subject, ANOVA revealed an overall main effect on participants MS, or number of items attempted across time, $F(2, 246) = 4.77, p = .009$, with $\eta^2 = .037$. There were also
between subject main effects on MS for each time pressure condition, $F(2, 123) = 36.98, p < .001$, with an even higher effect size, $\eta^2 = .375$. The interactions, however were not significant, $F(4, 246) = 0.495, p = .740$.

**Mean Correct; Number of Correct Responses**

A within subjects ANOVA revealed an overall main effect over time on participants’ MC or number of correct item responses, $F(2, 246) = 5.68, p = .004$, with $\eta^2 = .044$. There were also between-subjects main effects on MC for each time pressure condition, $F(2, 123) = 23.09, p < .001$, with a larger effect size, $\eta^2 = .273$. The interactions were not significant, $F(4, 246) = .324, p = .122$.

**Comparing Sequences**

A one-way ANOVA revealed that there were no differences among participants on OPC, MS, or MC as a function of the image sequence that participants were placed in $F(2, 123) = 1.78, p = .174$, $F(2, 123) =1.55, p = .216$, and $F(2, 123) = 2.84, p = .062$ respectively.
Planned Comparisons

**Overall Percent Correct**

Planned Comparisons revealed that the overall percent correct, or number of correct responses out of number attempted, for the 2-second condition \( (M = 83.43, SD = 4.02) \) \( n = 42 \), was significantly lower than OPC for the 4-second condition \( (M = 87.78, SD = 4.64) \) \( n = 42 \), \( t(123) = -4.617, p < .001 \), with \( \eta^2 = .158 \). However, OPC for the 4-second condition was not significantly different than OPC for the 2-second with payment contingency \( (M = 86.28, SD = 4.26) \) \( n = 42 \), \( t(123) = 1.59, p = .114 \), with \( \eta^2 = .02 \).

*Figure 12.* Planned comparisons for time pressure conditions on OPC.
Percent Correct at Time 1

Planned comparisons revealed that the percent correct (PC) at time 1, or the first 5-minute task, in the 2-second condition ($M = 82.26, SD = 6.92$), was significantly lower than PC in the 4-second condition ($M = 87.31, SD = 6.77$), $t(123) = -3.52, p = .001$, with $\eta^2 = .09$. However, PC for the 4-second condition was not significantly different than PC for the 2-second with payment contingency condition ($M = 85.33, SD = 6.0$), $t(123) = 1.38, p = .171$, with $\eta^2 = .015$.

Figure 13. Planned comparisons for time pressure conditions at time 1 on PC.
Percent Correct at Time 2

Planned comparisons revealed that PC for the 2-second condition ($M = 84.69, SD = 5.52$), was significantly lower than PC performance for the 4-second condition ($M = 87.57, SD = 6.46$), $t(123) = -2.19, p = .03$, with $\eta^2 = .038$. However, PC for the 4-second condition was not significantly different than PC for the 2-second with payment contingency condition ($M = 86.76, SD = 6.06$), $t(123) = 0.62, p = .539$, with $\eta^2 = .003$.

![Figure 14. Planned comparisons for time pressure conditions at time 2 on PC.](image)

Percent Correct at Time 3

Planned comparisons revealed that PC for the 2-second condition ($M = 83.62, SD = 64$)
was significantly lower than PC for the 4-second condition ($M = 88.43, SD = 6.70$), $t(123) = -3.08, p = .003$, with $\eta^2 = .072$. However, PC for the 4-second condition was not significantly different than the PC for the 2-second with payment contingency condition ($M = 86.95, SD = 7.73$), $t(123) = 0.95, p = .346$, with $\eta^2 = .007$.

**Figure 15.** Planned comparisons for time pressure conditions at time 3 on PC.

**Figure 16.** Overview of PC across duration or overall task times.
Mean Speed

As expected, planned comparisons revealed that the 2-second condition ($M = 616.76$, $SD = 49.05$) was significantly faster in that they responded to more items than the 4-second condition ($M = 528.67$, $SD = 70.00$), $t(123) = 7.20$, $p < .001$, with $\eta^2 = .31$. The MS for the 4-second condition was also significantly different from the 2-second with payment contingency condition ($M = 622.43$, $SD = 45.97$), $t(123) = -7.67$, $p < .001$, with $\eta^2 = .32$.

![Mean Speed Graph](image)

Figure 17. Mean speed over the entire 15-minutes of task time. Higher speed represents faster responding.

Mean Correct

Total number of correct responses, or MC, for the 2-second condition ($M = 516.02$, $SD = 45.70$) was significantly higher than MC for the 4 second condition ($M = 463.41$, $SD = 61.46$), $t(123) = 4.67$, $p < .001$, with $\eta^2 = .15$. The 4-second condition was also significantly lower on
MC than the 2 second with contingent pay condition ($M = 537.98$, $SD = 46.34$), $t (123) = -6.61$, $p < .001$, with $\eta^2 = .26$.

\[ \text{Figure 18. Mean correct Reponses over the entire 15 minutes of task time per time pressure condition.} \]

\textbf{Planned Comparisons for Image Sequences}

\textbf{Sequence 1 OPC}

The overall percent correct (OPC) for the 2-second condition, sequence one ($M = 83.91$, $SD = 3.50$) was significantly lower from the OPC performance for the 4-second, sequence one condition ($M = 88.62$, $SD = 4.95$), $t(39) = -2.82$, $p = .007$, with $\eta^2 = .169$. However, OPC for the 4-second, sequence one condition was not significantly different than the OPC for the 2-second with payment contingency, sequence one condition ($M = 87.01$, $SD = 4.68$), $t(39) = 0.971$, $p = .338$, with $\eta^2 = .023$. 
Sequence 2 OPC

OPC for the 2-second condition \( (M = 83.14, SD = 4.70) \) was significantly different from OPC for the 4-second condition \( (M = 88.48, SD = 3.94) \), \( t(39) = -3.40, p = .002 \), with \( \eta^2 = .228 \). OPC for the 4-second condition was not significantly different than the OPC for the 2-second with payment contingency condition \( (M = 87.05, SD = 3.77) \) \( t(39) = 0.907, p = .370 \), with \( \eta^2 = .021 \).

Sequence 3 OPC

OPC for the 2-second condition \( (M = 83.24, SD = 4.02) \) only approached significantly different scores from OPC for the 4-second condition \( (M = 86.22, SD = 4.88) \), \( t(39) = -1.80, p = .08 \), with \( \eta^2 = .076 \). OPC for the 4-second condition was not significantly different than the OPC for the 2-second with payment contingency condition \( (M = 84.77, SD = 4.20) \), \( t(39) = 0.88, p = .386 \), with \( \eta^2 = .019 \).

Discussion of Experiment Two

The dramatic influence of participants' voluntary control, or their decision to avoid tasks that are not perceived worthwhile was evidenced further by the results from experiment two. The overall task average performance was not only replicated from experiment one but also was found to remain intact over all three periods of time. In addition varying the sequence of presentations did not lessen these effects. The second study is confirmatory of the previous findings from experiment one.
There were significantly lower scores on OPC for the 2-second (stress) condition than the 4-second condition, however when those in an analogous 2-second (stress) condition were offered minimal payment for good performance, there were no differences from the superiorly performing 4-second condition. This strengthens the argument of Kantowitz (1988) that participant by setting interactions exist, and secondly that participants have control over their performance, and may be more apt to employ task avoidance behavior when stress is present than when it is not. This finding has serious implications for explanations of lab-based stress and human performance experiments through metaphorical “resource depletion”. A simple metaphor no longer suffices as the explanation. While still very useful for communication between professionals, the applied nature of human performance and task performance research demands a more complete explanation and diagnostic model. It is all to often that academicians and practitioners alike are rewarded for publication where results are rarely tested against real-world conditions.

**Modeling and Simulation**

Effective modeling and simulation of artificial agents relies heavily on the research results coming from applied human factors and cognitive modeling research. Predictive and descriptive models are being rapidly applied to the underlying attributes that drive the behavior of artificial agents used for various purposes. For example, it is crucial for military training artificial agents to represent realistic human characteristics of enemy combatants. More often than not, combat training involves the likelihood of fatalities and significantly heightened stress. Unfortunately, rapid and premature generalization of empirical findings research to these models
lead to non-representative agents and which can adversely impact soldier training and subsequent operational activities.

The present study suggests the existence of major confounds among widely accepted and available stress and human performance data. While it is not always possible to replicate field conditions, the cognitive motivations and human characteristics of the population under study must be constant for the results to approach ecological validity. While the field of simulation and training continues to grow, the models that drive the simulations can either enhance or detract from their intent, leaving human error and fatalities at stake. The simulation therefore is only as good as the underlying model. It is only hopeful that the millions of government dollars spent on advanced virtual environments and simulation systems can be continuously updated with more adequate and sophisticated predictive models from ecologically valid research. As an extension of the studies herein, more diagnostic research and models are under development in order to result in decision matrices, taxonomies, and architectures for modeling and simulation design validation, verification and effective application.

**Trends Over Time: Learning Trends and Task Disassociation**

This study demonstrates task performance trends over time. The three time-pressure conditions revealed somewhat different trends for the task duration. Both the 4-second condition and the 2-second with payment contingency were gradually increasing their performance, or overall percent correct from time one to time two and then three. This suggests not only an initial learning trend but also an attempt to continue or sustain the performance over time. On the other hand the 2-second, stress condition, initially increased from time one to time two, but diminished
as a suggested function of task avoidance. This pattern of results is taken to suggest that resource depletion is not the cause of the diminished performance but participant goals and motivations by task type contributed to a task avoidance or disinterest in sustaining performance on the task. This was an expected effect evidenced by the analogous condition with payment contingency sustaining and increasing in performance. Further analyses of self-reports and physiological data across the time intervals may lead to more diagnostic definitions of the reasons behind the trends.

**Speed-Accuracy Tradeoff**

A speed-accuracy tradeoff is not evident in this experiment. It is often the case that when participants perform faster, they also perform less accurately. Shifts in cognitive strategy such as this may have actually been employed as time-pressure produced faster responding (most likely due to the force not the option to respond faster) but also more accurate responses, which may have been a function of more opportunity to respond. With this study it is a possible confound to determine speed-accuracy tradeoff shifts because the independent variable conditions forced time pressure and thus forced speed. One would expect, based on previous literature that the forced speed should have resulted in less accuracy. This would most likely be the case *if* both groups had an even number of trials completed to compare. Further studies and even further analyses on these data could control number of trials or randomly select a fixed number of trials for each condition. This would then hold the forced aspect of speed constant and then one could determine if lower accuracy was evident within the time-pressure group.
CHAPTER FIVE: GENERAL DISCUSSION

Future Developments and Considerations

An interesting application of the data collected in this study would be to eventually determine a participant’s level or an Index of Voluntary Operational Control (IVOC). An IVOC would be an index composed of foundational factors such as “direction” (meaningfulness), “intensity” (need for achievement, competitiveness orientation, and effort extended) and “persistence” (goal changes over time). It would consist of two rather orthogonal factor components of participant’s state and trait characteristics used to define the discerning operator voluntary control parameters, 1) Task Interest (TI), which is a function of intrinsic task motivation and more state variables (from the DSSQ and BPS) and 2) Directed Energy (DE) which would represent more of the operator’s traits such as need for achievement (from the AMI), competitiveness orientation (from the CS). These 2 factors would be mapped or applied across time to develop high-low parameters or boundaries for where performance is expected to fall if voluntary control is suspected and changes would be due to task avoidance. The ratio of ‘actual to highest possible’ task performance should fall between the ratios of the ‘actual to highest’ TI and DE values when a stressor is not present, or if there is a chance the participant is avoiding the task. When it does, this would indicate that the participant may be in control of their performance and therefore any change in task performance over time (i.e., vigilance decrement) would be accounted for by task avoidance as opposed to depleted resources or an inability to perform. When an individual’s performance trends fall below the TI and DE parameters (as in Figure 19) one can assume that something other than task-avoidance or voluntary control may be causing the performance difference (possibly an stress related inability,
currently conceived as depleted abilities or resources). When the performance ratio rises above the TI and DE parameters, it would then be expected that performance becomes rather automatic to the participant, not requiring a comparable TI or DE expenditure level. This function will be proposed for further research as it could provide very useful insight into the covert mechanisms of the human participant. The data obtained from these experiments are expected to contain enough information for a preliminary development of the INDEX OF VOLUNTARY CONTROL so as to depict, or parse out, a participant’s possible task-avoidance versus his or her inability to perform among future lab based experiments.

Figure 19. Task interest and directed energy reflected upon task performance. A possible index of task avoidance or participant voluntary control.

Once developed an assumption to the task-avoidance function is that the user understands the task and how to accomplish the task. This can be determined by using a pretest, or practice
Hancock and Warm (1989) describe the importance of the initial value of the stressor (or structure) on the stress experience, and that may be quite different than that of the adapted value for the majority of the time interval. The differential changes in adaptation rate are not always linear or curvilinear, nor is the slope easily predicted. Therefore in order to obtain the value of a stress-task situation one should consider both the initial meaningfulness value of the stress and the task as well as the differential rate of stress-task adaptation and change over time (as opposed to quantified or averaged time chunks). The additional effort of diagnosing and IVOC, task-avoidance and developing a functionally predictive IVOC will need to be facilitated by the use of many different indicators of performance trends over time, as were outlined and collected herein.
STATE QUESTIONNAIRE

General Instructions. This questionnaire is concerned with your feelings and thoughts at the moment. We would like to build up a detailed picture of your current state of mind, so there are quite a few questions, divided into four sections. Please answer every question, even if you find it difficult. Answer, as honestly as you can, what is true of you. Please do not choose a reply just because it seems like the 'right thing to say'. Your answers will be kept entirely confidential. Also, be sure to answer according to how you feel AT THE MOMENT. Don't just put down how you usually feel. You should try and work quite quickly: there is no need to think very hard about the answers. The first answer you think of is usually the best.

Before you start, please provide some general information about yourself.

Age.............. (years)                                         Sex.   M  F   (Circle one)
Occupation............................................................
If student, state your course...................................
Date today.....................                                Time of day now..............

1. MOOD STATE
First, there is a list of words, which describe people's moods or feelings. Please indicate how well each word describes how you feel AT THE MOMENT. For each word, circle the answer from 1 to 4 which best describes your mood.

<table>
<thead>
<tr>
<th>Word</th>
<th>Definitely</th>
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<th>Slightly</th>
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<td>4</td>
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</tbody>
</table>

2. MOTIVATION
Please answer some questions about your attitude to the task you are about to do. Rate your agreement with the following statements by circling one of the following answers:

Extremely = 4    Very much = 3    Somewhat = 2    A little bit = 1   Not at all = 0

1. I expect the content of the task will be interesting
   0 1 2 3 4
2. The only reason to do the task is to get an external reward (e.g. payment)
   0 1 2 3 4
3. I would rather spend the time doing the task on something else
   0 1 2 3 4
4. I am concerned about not doing as well as I can
   0 1 2 3 4
5. I want to perform better than most people do
   0 1 2 3 4
6. I will become fed up with the task
   0 1 2 3 4
7. I am eager to do well
   0 1 2 3 4
8. I would be disappointed if I failed to do well on the task
   0 1 2 3 4
9. I am committed to attaining my performance goals
   0 1 2 3 4
10. Doing the task is worthwhile
    0 1 2 3 4
11. I expect to find the task boring
    0 1 2 3 4
12. I feel apathetic about my performance
    0 1 2 3 4
13. I want to succeed on the task
    0 1 2 3 4
14. The task will bring out my competitive drives
    0 1 2 3 4
15. I am motivated to do the task
    0 1 2 3 4

16. Please rate the MENTAL DEMAND of the task: How much mental and perceptual activity was required?
   Low 0 1 2 3 4 5 6 7 8 9 10 High

17. Please rate the PHYSICAL DEMAND of the task: How much physical activity was required?
   Low 0 1 2 3 4 5 6 7 8 9 10 High

18. Please rate the TEMPORAL DEMAND of the task: How much time pressure did you feel due to the pace at which the task elements occurred?
   Low 0 1 2 3 4 5 6 7 8 9 10 High

19. Please rate your PERFORMANCE: How successful do you think you were in accomplishing the goals of the task?
   Low 0 1 2 3 4 5 6 7 8 9 10 High

20. Please rate your EFFORT: How hard did you have to work (mentally and physically) to accomplish your level of performance?
   Low 0 1 2 3 4 5 6 7 8 9 10 High
21. Please rate your FRUSTRATION: How discouraged, irritated, stressed and annoyed did you feel during the task?
Low 0 1 2 3 4 5 6 7 8 9 10 High

3. THINKING STYLE

In this section, we are concerned with your thoughts about yourself: how your mind is working, how confident you feel, and how well you expect to perform on the task. Below are some statements which may describe your style of thought RIGHT NOW. Read each one carefully and indicate how true each statement is of your thoughts AT THE MOMENT. To answer, circle one of the following answers:

Extremely = 4    Very much = 3    Somewhat = 2    A little bit = 1   Not at all = 0

1. I'm trying to figure myself out.                                                     0   1   2   3   4
2. I'm very aware of myself.                                                            0   1   2   3   4
3. I'm reflecting about myself.                                                         0   1   2   3   4
4. I'm daydreaming about myself.                                                       0   1   2   3   4
5. I'm thinking deeply about myself.                                                    0   1   2   3   4
6. I'm attending to my inner feelings.                                                  0   1   2   3   4
7. I'm examining my motives.                                                            0   1   2   3   4
8. I feel that I'm off somewhere watching myself.                                      0   1   2   3   4
9. I feel confident about my abilities.                                                 0   1   2   3   4
10. I am worried about whether I am regarded as a success or failure.                  0   1   2   3   4
11. I feel self-conscious.                                                              0   1   2   3   4
12. I feel as smart as others.                                                          0   1   2   3   4
13. I am worried about what other people think of me.                                  0   1   2   3   4
14. I feel confident that I understand things.                                          0   1   2   3   4
15. I feel inferior to others at this moment.                                           0   1   2   3   4
16. I feel concerned about the impression I am making.                                  0   1   2   3   4
17. I feel that I have less scholastic ability right now than others.                  0   1   2   3   4
18. I am worried about looking foolish.                                                 0   1   2   3   4
19. My attention is directed towards things other than the task.                      0   1   2   3   4
20. I am finding physical sensations such as muscular tension distracting.             0   1   2   3   4
21. I expect my performance will be impaired by thoughts irrelevant to the task.      0   1   2   3   4
22. I have too much to think about to be able to concentrate on the task.             0   1   2   3   4
23. My thinking is generally clear and sharp.                                           0   1   2   3   4
24. I will find it hard to maintain my concentration for more than a short time.      0   1   2   3   4
25. My mind is wandering a great deal.                                                 0   1   2   3   4
26. My thoughts are confused and difficult to control.                                 0   1   2   3   4
27. I expect to perform proficiently on this task.                                     0   1   2   3   4
28. Generally, I feel in control of things.                                             0   1   2   3   4
29. I can handle any difficulties I encounter                                          0   1   2   3   4
30. I consider myself skillful at the task                                             0   1   2   3   4

4. THINKING CONTENT

This set of questions concerns the kinds of thoughts that go through people's heads at particular times, for example while they are doing some task or activity. Below is a list of thoughts, some of which you might have had recently. Please indicate roughly how often you had each thought DURING THE LAST TEN MINUTES or so, by circling a number from the list below.
<p>| | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>1.</td>
<td>I thought about how I should work more carefully.</td>
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<tr>
<td>2.</td>
<td>I thought about how much time I had left.</td>
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<tr>
<td>3.</td>
<td>I thought about how others have done on this task.</td>
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<td>4.</td>
<td>I thought about the difficulty of the problems.</td>
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<td>5.</td>
<td>I thought about my level of ability.</td>
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<td>6.</td>
<td>I thought about the purpose of the experiment.</td>
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<td>7.</td>
<td>I thought about how I would feel if I were told how I performed.</td>
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<tr>
<td>8.</td>
<td>I thought about how often I get confused.</td>
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<td>9.</td>
<td>I thought about members of my family.</td>
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<td>10.</td>
<td>I thought about something that made me feel guilty.</td>
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<td>11.</td>
<td>I thought about personal worries.</td>
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<td>12.</td>
<td>I thought about something that made me feel angry.</td>
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<td>13.</td>
<td>I thought about something that happened earlier today.</td>
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<td>14.</td>
<td>I thought about something that happened in the recent past (last few days, but not today).</td>
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<tr>
<td>15.</td>
<td>I thought about something that happened in the distant past</td>
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<tr>
<td>16.</td>
<td>I thought about something that might happen in the future.</td>
</tr>
</tbody>
</table>
STATE QUESTIONNAIRE

General Instructions

This questionnaire is concerned with your feelings and thoughts while you were performing the task. We would like to build up a detailed picture of your current state of mind, so there are quite a few questions, divided into four sections. Please answer every question, even if you find it difficult. Answer, as honestly as you can, what is true of you. Please do not choose a reply just because it seems like the 'right thing to say'. Your answers will be kept entirely confidential. Also, be sure to answer according to how you felt WHILE PERFORMING THE TASK. Don't just put down how you usually feel. You should try and work quite quickly: there is no need to think very hard about the answers. The first answer you think of is usually the best.

1. MOOD STATE

First, there is a list of words which describe people's moods or feelings. Please indicate how well each word describes how you felt WHILE PERFORMING THE TASK. For each word, circle the answer from 1 to 4 which best describes your mood.

<table>
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</table>
2. MOTIVATION AND WORKLOAD

Please answer the following questions about your attitude to the task you have just done. Rate your agreement with the following statements by circling one of the following answers:

Extremely = 4    Very much = 3    Somewhat = 2    A little bit = 1    Not at all = 0

1. The content of the task was interesting
   0

2. The only reason to do the task is to get an external reward (e.g. payment)
   0 1 2 3 4

3. I would rather have spent the time doing the task on something else
   0 1 2 3 4

4. I was concerned about not doing as well as I can
   0 1 2 3 4

5. I wanted to perform better than most people do
   0 1 2 3 4

6. I became fed up with the task
   0 1 2 3 4

7. I was eager to do well
   0 1 2 3 4

8. I would be disappointed if I failed to do well on this task
   0 1 2 3 4

9. I was committed to attaining my performance goals
   0 1 2 3 4

10. Doing the task was worthwhile
    0 1 2 3 4

11. I found the task boring
    0 1 2 3 4

12. I felt apathetic about my performance
    0 1 2 3 4

13. I wanted to succeed on the task
    0 1 2 3 4

14. The task brought out my competitive drives
    0 1 2 3 4

15. I was motivated to do the task
    0 1 2 3 4

16. Please rate the MENTAL DEMAND of the task: How much mental and perceptual activity was required?
    Low 0  1  2  3  4  5  6  7  8  9  10  High

17. Please rate the PHYSICAL DEMAND of the task: How much physical activity was required?
    Low 0  1  2  3  4  5  6  7  8  9  10  High

18. Please rate the TEMPORAL DEMAND of the task: How much time pressure did you feel due to the pace at which the task elements occurred?
    Low 0  1  2  3  4  5  6  7  8  9  10  High

19. Please rate your PERFORMANCE: How successful do you think you were in accomplishing the goals of the task?
    Low 0  1  2  3  4  5  6  7  8  9  10  High

20. Please rate your EFFORT: How hard did you have to work (mentally and physically) to accomplish your level of performance?
21. Please rate your FRUSTRATION: How discouraged, irritated, stressed and annoyed did you feel during the task?
Low 0 1 2 3 4 5 6 7 8 9 10 High

**. THINKING STYLE**

In this section, we are concerned with your thoughts about yourself: how your mind is working, how confident you feel, and how well you believed you performed on the task. Below are some statements which may describe your style of thought during task performance. Read each one carefully and indicate how true each statement was of your thoughts **WHILE PERFORMING THE TASK**. To answer circle one of the following answers:   Extremely = 4   Very much = 3   Somewhat = 2   A little bit = 1   Not at all = 0

<table>
<thead>
<tr>
<th>Statement</th>
<th>0</th>
<th>1</th>
<th>2</th>
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<th>4</th>
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<tbody>
<tr>
<td>I tried to figure myself out.</td>
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<td>I was very aware of myself.</td>
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<td>I reflected about myself.</td>
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<td>I daydreamed about myself.</td>
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<td>I thought deeply about myself.</td>
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<td>I attended to my inner feelings.</td>
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<td>I examined my motives.</td>
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<td>I felt that I was off somewhere watching myself.</td>
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<td>I felt confident about my abilities.</td>
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<td>I was worried about whether I am regarded as a success or failure.</td>
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<td>I felt self-conscious.</td>
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<td>I felt as smart as others.</td>
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<td>I was worried about what other people think of me.</td>
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<td>I felt confident that I understood things.</td>
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<td>I felt inferior to others.</td>
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<td>I felt concerned about the impression I was making.</td>
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<td>I felt that I had less scholastic ability than others.</td>
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<tr>
<td>I was worried about looking foolish.</td>
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<tr>
<td>My attention was directed towards things other than the task.</td>
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<tr>
<td>I found physical sensations such as muscular tension distracting.</td>
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</tbody>
</table>
21. My performance was impaired by thoughts irrelevant to the task. 3 4
22. I had too much to think about to be able to concentrate on the task. 3 4
23. My thinking was generally clear and sharp. 3 4
24. I found it hard to maintain my concentration for more than a short time. 3 4
25. My mind wandered a great deal. 3 4
26. My thoughts were confused and difficult to control 3 4
27. I performed proficiently on this task. 0 1 2 3 4
28. Generally, I felt in control of things. 3 4
29. I was able to handle any difficulties I encountered 3 4
30. I consider myself skillful at the task 3 4

4. THINKING CONTENT
This set of questions concerns the kinds of thoughts that go through people's heads at particular times, for example while they are doing some task or activity. Below is a list of thoughts, some of which you might have had recently. Please indicate roughly how often you had each thought during THE LAST TEN MINUTES (while performing the task), by circling a number from the list below.

1= Never  2= Once  3= A few times  4= Often  5= Very often

1. I thought about how I should work more carefully. 1 2 3 4 5
2. I thought about how much time I had left. 1 2 3 4 5
3. I thought about how others have done on this task. 1 2 3 4 5
4. I thought about the difficulty of the problems. 1 2 3 4 5
5. I thought about my level of ability. 1 2 3 4 5
6. I thought about the purpose of the experiment. 1 2 3 4 5
7. I thought about how I would feel if I were told how I performed. 1 2 3 4 5
8. I thought about how often I get confused. 1 2 3 4 5
9. I thought about members of my family. 1 2 3 4 5
10. I thought about something that made me feel guilty. 1 2 3 4 5
11. I thought about personal worries. 1 2 3 4 5
12. I thought about something that made me feel angry. 1 2 3 4 5
13. I thought about something that happened earlier today. 1 2 3 4 5
14. I thought about something that happened in the recent past (last few days, but not today). 1 2 3 4 5
15. I thought about something that happened in the distant past 1 2 3 4 5
16. I thought about something that might happen in the future. 1 2 3 4 5
APPENDIX B
COPING INVENTORY FOR TASK STRESS (CITS)
APPENDIX D
COPING INVENTORY FOR TASK STRESS (CITS)

Think about how you dealt with any difficulties or problems that arose while you were performing the task you have just performed. Below are listed some options for dealing with problems such as poor performance or negative reactions to doing the task. Please indicate how much you used each option, specifically as a deliberately chosen way of dealing with problems. To answer circle one of the following answers:

Extremely = 4  Very much = 3  Somewhat = 2  A little bit = 1  Not at all = 0

1. Worked out a strategy for successful performance
2. Worried about what I would do next
3. Stayed detached or distanced from the situation
4. Decided to save my efforts for something more worthwhile
5. Blamed myself for not doing better
6. Became preoccupied with my problems
7. Concentrated hard on doing well
8. Focused my attention on the most important parts of the task
9. Acted as though the task wasn't important
10. Didn't take the task too seriously
11. Wished that I could change what was happening
12. Blamed myself for not knowing what to do
13. Worried about my inadequacies
14. Made every effort to achieve my goals
15. Blamed myself for becoming too emotional
16. Was single-minded and determined in my efforts to overcome any problems
17. Gave up the attempt to do well
18. Told myself it wasn't worth getting upset
19. Was careful to avoid mistakes
20. Did my best to follow the instructions for the task
21. Decided there was no point in trying to do well
APPENDIX C
BOREDOM PRONENESS SCALE
BOREDOM PRONENESS SCALE

Directions: Circle "TRUE" for sentences that are true for you or "FALSE" for sentences that are false for you.

1. It is easy for me to concentrate on my activities.  
2. Frequently when I am working I find myself worrying about other things.  
3. Time always seems to be passing slowly.  
4. I often find myself at "loose ends," not knowing what to do.  
5. I am often trapped in situations where I have to do meaningless things.  
6. Having to look at someone's home movies or travel slides bores me tremendously.  
7. I have projects in mind all the time, things to do.  
8. I find it easy to entertain myself.  
9. Many things I have to do are repetitive and monotonous.  
10. It takes more stimulation to get me going than most people.  
11. I get a kick out of most things I do.  
12. I am seldom excited about my work.  
13. In any situation I can usually find something to do or see to keep me interested.  
14. Much of the time I just sit around doing nothing.  
15. I am good at waiting patiently.  
16. I often find myself with nothing to do--time on my hands.  
17. In situations where I have to wait, such as a line, I get very restless.  
18. I often wake-up with a new idea.  
19. It would be very hard for me to find a job that is exciting enough.  
20. I would like more challenging things to do in life.  
21. I feel that I am working below my abilities most of the time.  
22. Many people would say that I am a creative or imaginative person.  
23. I have so many interests, I don't have time to do everything.  
24. Among my friends, I am the one who keeps doing something the longest.  
25. Unless I am doing something exciting, even dangerous, I feel half-dead and dull.  
26. It takes a lot of change and variety to keep me really happy.  
27. It seems that the same things are on television or at the movies all the time; it's getting old.  
28. When I was young, I was often in monotonous and tiresome situations.
APPENDIX D
RAY ACHIEVEMENT MOTIVATION INDEX
Directions: Circle "TRUE" for sentences that are true for you or "FALSE" for sentences that are false for you.

| TRUE | FALSE | 1. Do you tend to plan ahead for your job or career? |
| TRUE | FALSE | 2. Are you an ambitious person? |
| TRUE | FALSE | 3. Would you describe yourself as being lazy? |
| TRUE | FALSE | 4. Are you inclined to take life as it comes without much planning? |
| TRUE | FALSE | 6. Is being comfortable more important to you than getting ahead? |
| TRUE | FALSE | 7. Are you satisfied to be no better than most other people at your job? |
| TRUE | FALSE | 8. Would you prefer to work with a congenial but incompetent partner rather than with a difficult but highly competent one? |
| TRUE | FALSE | 9. Is "getting on in life" important to you? |
| TRUE | FALSE | 10. Do you get restless and annoyed when you feel you are wasting time? |
| TRUE | FALSE | 11. Have you always worked hard in order to be among the best in your own line? |
| TRUE | FALSE | 12. Do you like to make improvements to the way the organization you belong to functions? |
| TRUE | FALSE | 13. Do you take trouble to cultivate people who may be useful to you in your career? |
| TRUE | FALSE | 14. Will days often go by without your having done a thing? |

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COMPETITIVENESS SCALE

Directions: Circle “TRUE” for sentences that are true for you or “FALSE” for sentences that are false for you.

1. I would want to get an A because that is the best grade a person can get.
2. I perform better when I am competing against someone rather than when I am the only one striving for a goal.
3. I do not care to be the best that I can be.
4. When applying for an award I focus on my qualifications for the award and why I deserve it, not on how the other applicants compare to me.
5. I do not feel that winning is important in both work and games.
6. When I win an award or game it means that I am the best compared to the game.
7. In school, I always liked to be the first one finished with a test.
8. I am not disappointed if I do not reach a goal that I have set for myself.
9. I have always wanted to be better than others.
10. Achieving excellence is not important to me.
11. When nominated for an award, I focus on how much better or worse than the other candidates’ qualifications are as compared to mine.
12. I would want an A because that means that I did better than other people.
13. I wish to excel in all that I do.
14. Because it is important that a winner is decided, I do not like to leave a game unfinished.
15. I would rather work in an area in which I can excel, even if there are other areas that would be easier or would pay more money.
Informed Consent

Thank you for agreeing to serve as a participant in this project. The name of the primary researcher is Christina S. Morris, Applied Experimental Researcher, and may be reached at 407-823-0069. The faculty chair of this project is Peter A. Hancock, Ph.D. and may be reached at 407-823-2910. The purpose of this project is to determine how human task performance changes under different task conditions. Some conditions may be more motivating that others and some may be distracting, thus changing typical performance levels. The tasks you will be asked to perform are computerized. You will be asked to use an input response pad consisting of 1-3 buttons to press in response to the tasks. During the tasks there will be a non-intrusive peripheral sensor placed on 3 fingers of your opposite hand. The sensors will be collecting skin response, blood volume, and heart rate data. The sensors never protrude the skin and are comfortably placed on the fingertips. Some conditions may involve listening to white noise at various levels. While there are no known long-term effects of listening to white noise, it may become distracting or annoying as time progresses. You will also be asked some questions periodically with respect to your perceived motivation, workload, and opinions about the tasks. All of your data and responses will be anonymous and you will never be personally associated with your responses. You do not have to answer any question that you do not want to answer and may remove any of your data at any time. You may also withdraw your participation at any time during the experiment without any consequences. The only compensation for participating in this experiment is extra credit in a class where the instructor allows extra credit to be given for research participation. The total time expected for this experiment is between 45 and 60 minutes. You may also contact the UCFIRB office about your rights in the study. They are at the UCF office of research, Orlando Tech Center, 12443 Research Parkway, suite 207, Orlando, FL 32826.407-823-2901.

By signing this consent form you are agreeing that you understand the above statement, are voluntarily agreeing to participate in this study, and are at least 18 years of age.

__________________________________  ____________
Participant      Date

__________________________________  ____________
Principle Investigator    Date
March 3, 2003

Christina Morris
Department of Psychology
College of Arts and Sciences
University of Central Florida
4000 Central Florida Boulevard
Orlando, Florida 32816

Dear Ms. Morris:

With reference to your protocol entitled, “Conquering Task-Avoidance in Aversive Experimental Settings,” I am enclosing for your records the approved, executed document of the UCFIRB Form you had submitted to our office.

Please be advised that this approval is given for one year. Should there be any addenda or administrative changes to the already approved protocol, they must also be submitted to the Board. Changes should not be initiated until written IRB approval is received. Adverse events should be reported to the IRB as they occur. Further, should there be a need to extend this protocol, a renewal form must be submitted for approval at least one month prior to the anniversary date of the most recent approval and is the responsibility of the investigator (UCF).

Should you have any questions, please do not hesitate to call me at 823-2901.

Please accept our best wishes for the success of your endeavors.

Cordially,

Chris Grayson
Institutional Review Board (IRB)

Copies: Dr. Peter Hancock
IRB File
REFERENCES


